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CONFERENCE ON GRASSLAND IMPROVEMENT.

A CONFERENCE on Grassland Improvement organised by the Department of Agriculture for Scotland was held in Edinburgh from 9th to 11th April, 1940, and was attended by some 70 persons, mainly members of the staffs of the Agricultural Colleges. Nine of the papers read are included in this number of the *Journal*. Besides hearing and discussing these papers, those attending the Conference visited Boghall, the Experimental Farm of the Edinburgh and East of Scotland College of Agriculture, and Woodend and Harrysmuir Farms.

Mr P. R. Laird, C.B., Secretary of the Department, who presided, spoke as follows at the opening of the Conference :—

The purpose of the Conference is to consider how best to increase food production from our grassland. This includes the question of making up for the grassland ploughed for cropping.

The dimensions of the subject are shown by the following figures :—

The total area of Great Britain is 57 million acres and the area in agricultural or pastoral use in 1939 was 45·2 million acres. Ordinary farm land extended to 29·2 million acres, of which permanent grass accounted for 17 3 million and rotation grass for 3·6 million, the area actually under the plough being 8·3 million. There were besides 16 million acres of rough grazings. Since 1914 there has been a reduction of 2·7 million acres of farm land, tillage declining by 2·1 million and grassland (rotation and permanent) by 0·6 million.

The distribution in Scotland in 1939 of a total area of 4·6 million acres of farm land was 1·6 million of permanent grass, 1·5 million of rotation grass and 1·5 million of tillage. There were also 10·6 million acres of rough grazings.

Since 1914 we have lost 230,000 acres of farm land, tillage being reduced by 330,000 and rotation grass by 30,000, while permanent grass has increased by 130,000. Thus even if the ploughing programme is successful in adding 260,000 acres to the tillage area, we shall still have 2¾ million acres of grassland, apart from the vast area of rough grazings.

The important figures for Scotland thus are :—

Rotation Grass	-	1·5 million acres.
Permanent Grass	-	1·6 ,, ,,
Rough Grazings	-	10·6 ,, ,,

All three are used for grazing stock, while the first two also produce winter keep—hay, silage and dried grass. The methods of improvement that can be applied to the first two are drainage, ploughing and re-seeding, surface treatment (scratching, seeding and manuring), and management of grazing. Rough grazings can be improved by draining, heather-burning, bracken-cutting and well-planned stocking.

These subjects involve many difficult and complex questions, both technical and economic. The papers that will be read should give rise to much discussion and should provide suggestions for methods varying in different districts and under different conditions. The staffs of the Agricultural Colleges have a most important duty in giving guidance to farmers and to the Agricultural Executive Committees.

THE IMPROVEMENT OF GRASSLAND IN RELATION TO AGRICULTURE IN GENERAL.

Professor J. A. S. WATSON, M.A.,
University of Oxford

I HAVE been given the difficult task of surveying the whole problem of grassland improvement in relation to the new calls that are being made upon our agriculture, and of sorting out the problem into its constituent parts.

Grassland serves three distinct purposes. A given field is often required to serve two or all three of them, but we shall keep our minds clearer if we set out each purpose separately.

(1) The first is to provide pasturage in summer, and the objects of improvement as pasturage are fourfold, viz. :—
   (*a*) To produce a larger total quantity of keep.
   (*b*) To produce herbage of higher nutritive value. This is actually more important than an increase in quantity. It is a question partly of botanical composition, partly of fertilizing and partly of grazing at the right stage and not over-grazing.
   (*c*) To get a more favourable distribution of keep throughout the season, in order to lengthen the period of cheap feeding and shorten the period of expensive house feeding. The early bite has a special value under war-time conditions.
   (*d*) To do these things without harm to the health of the animals, and particularly to avoid the troubles of overstocking, such as stomach worm in sheep.

(2) The second object is to provide conservation products—hay, dried grass and ensilage. Here again improvement means better yields and higher quality of herbage; but we have also the problem of choosing, for the particular crop and the given weather conditions, the most efficient of the various conservation processes. A bad hay season will be a special disaster under war conditions, and farmers must have silage in mind at least as an alternative.

(3) The third aim is to use the sward as a better means of accumulating fertility for the use of subsequent arable crops. The amount of fertility that should be accumulated is one point. The other is the most effective method of converting this fertility into a useful product—in other words, how best to realise our investment.

Let us look at some of the systems of grassland management that have been worked out in the past to meet prevailing conditions in Scotland.

The first is the carse-land timothy meadow of the days when there was a big demand for hay in the cities. The timothy was left down as long as it remained as a clean sward. It was heavily dosed with nitrogen, and produced a large yield of a commodity that commanded a good price. When the sward gave out, it was broken up, cropped for perhaps two years and laid down again. Here was a profitable system, worked out by the farmer himself, which produced a very large output from the land. The timothy meadow is one of the most productive forms of grassland and is worth consideration as an item in war-time policy.

Next let us consider the second-rate land at an elevation of, say, 600 to 900 feet, carrying breeding sheep and producing store cattle. Farmers have realised that the land should be treated at intervals with lime and phosphates, that the drainage should be maintained and that the sward should be broken up and renewed from time to time. So long as economic conditions remained reasonably encouraging these things were done. Lately, however, the arable crops have not paid their costs, returns from the grazing itself have been low and productivity has rather seriously declined. Cheap mineral phosphates, the slag and lime subsidies, and improved grass-seeds mixtures have done something to check the process of deterioration, but rising labour costs have acted in the opposite direction. We must try to restore these lands to their former more productive state.

In the third place there are the mountain grazings. Here it must be admitted that, at least in certain areas, the system adopted some 150 years ago has failed. Money has been made at times, but there has been a decline in the fertility of the land which, in the mass, has been serious. A permanent system of grassland management, that will leave a profit and maintain the value of the grazing, is still to seek. This subject will be considered from several points of view in later papers. It is too complex a problem for any brief dicta.

Finally, the three or four years' ley, which is typical of a wide stretch of the arable area of Scotland, has a long history. There have been constant efforts to make it serve its triple object—producing hay and pasturage and building up a store of fertility for arable crops. It began as a tumble-down pasture.[1] Two centuries ago our ancestors began to use grass and clover seeds—rye-grass, red clover and Dutch white. These seeds produced a quick sward and gave a good hay crop. But they constituted what was essentially a one-year mixture—indeed they were taken over from the Norfolk farmers who followed a four-course rotation. The early attempts to adapt the mixture for long-ley purposes were not very successful. Ribgrass was useful as a minor

[1] "If land be three year oot and three year in
It'll keep in guid heart till the deil gaes blin'."

constituent but not as a major one. Some of the "natural" grasses were tried but many, such as foxtail and meadow fescue, failed to establish themselves well from seed or were too slow in forming a sward. In fact the sward that was produced in those old days deteriorated rapidly, and was little better, by the end of the third year, than the old type of tumble-down pasture. The clover disappeared first and the rye-grass quickly followed.

Fifty years ago some improvement was achieved by introducing cocksfoot and timothy; these outlived the Dutch clover and the rye-grass. But the third year's grass was still, in the days of my youth, very poor, especially on inferior soils. Thirty years ago wild white clover came into general use—a very important step of progress, as we all know. Then came Finlay's and the Cockle Park work on mixtures, which showed the importance of balance between the various constituents and brought out the difference between the broad and the late-flowering strains of red clover. Among more recent developments are the use of mineral phosphates, and the use—still a matter of controversy—of the new pedigree indigenous strains of pasture plants.

The modern ley that has thus been evolved is a better thing than the old ley, and in general is better than a permanent sward. It is the main subject of the message that Sir George Stapledon has been working so hard to spread in the South, but the case does not need to be argued in Scotland.

How fully does the modern ley satisfy our requirements? In the districts mainly devoted to cattle—e.g. the dairy districts of the south-west—it seems to me to be nearly perfect. But where the stocking is predominantly with sheep (and sheep stocks have become far larger in many districts) the problem is not yet completely solved. In the first place, a good wild white clover ley will carry more sheep than is good for the sheep themselves. Stomach worm is becoming a problem in many areas, entailing resort to artificial feeding as well as to drenching; moreover, a heavy sheep stock generally means over-grazing in winter and early spring, which results in the depression of the grasses and the undesirably free development of the white clover. This leads, in turn, to over-accumulation of nitrogen and to over-luxuriant and unprofitable oat crops. A third point is that the forcing of a full crop of hay in the first year may do harm to the subsequent grazing.

One possible solution is a reversion to a better balance of stock, with a larger proportion of cattle and a smaller one of sheep. This is essentially a problem of relative prices, rather than of grassland management, but it has its importance. The other possibility is the use of a proportion of seed of the late pasture strains of rye-grass and cocksfoot, which suffer less from over-grazing in the period from February to May, and which con-

sequently compete better with clover in a sward used mainly for sheep.

But it seems to me that the big problem that faces us to-day is not the technical problem of the ley, and indeed is not a technical problem at all. It is rather a psychological one. For years the farmer has been driven to adopt a "ca' canny" policy in grassland management as well as in other things. The price situation has been all against a policy of bold spending and high farming. The farmer's survival has often depended on spending less rather than on producing more. The "ca' canny" policy has been especially in evidence on the poorer land. Many possible improvements have been ruled out because they seemed to hold out no prospect of a profit; and indeed old standards have not been maintained because economies have seemed necessary. Take two cases:—

I well remember a conversation I had at Dupplin with the late Lord Forteviot, whom many of us knew as a great enthusiast for better farming. I went to Dupplin to see a field that had been under the intensive system of grazing for a full season. Everything had been done according to the book, and the accounts for the first season had been made up and balanced. Lord Forteviot's summing up of the conclusions was this: "The intensive system has cost twice as much per acre as the ordinary system; it has produced rather more than twice as much grass per acre, and fed rather more than twice as many cattle per acre. Also it has lost just about twice as much money per acre."

Secondly, Sir George Stapledon has shown that under Welsh mountain conditions, it is possible in many cases to quadruple the carrying capacity and the output of live stock, at a cost for lime, slag, tillage and seed of perhaps six pounds an acre. But four acres of unimproved land might cost less in rent than one acre of improved ground in total expenses.

The main task before us is not that of convincing the farmer on the second-class and third-class land that a higher level of productivity is possible. He generally knows that already. What is necessary, in the first place, is to convince him that the higher level of productivity will be profitable. One knows, of course, that there are other difficulties—a shortage of labour, often a lack of capital, and the lag between expenditure and returns. A long-term policy is necessary, and the prospect of a short period of profitable prices is not enough encouragement for the bold policy that is needed. How then are we to develop our argument for the bolder policy that is required? The following are some suggestions.

(1) The processes of grassland improvement are to-day far cheaper, in relation to the value of the improvement, than they have been in the past. Fertilisers are cheap in relation to live-stock prices. Moreover, special help is available.

The quickest and most complete scheme for the improvement of second-rate pasture is to plough, slag and re-seed. The ploughing subsidy may be expected to go on; the slag subsidy also; tractors and implements are generally available at reasonable charges. We may argue, then, that the present opportunity for improvement should not be missed.

(2) The extension of arable cropping will reduce the acreage of grassland this year, and it is almost certain that there will be further loss of pasture acreage next year. It will be a pity if the war should leave us with seriously depleted herds and flocks. Some depletion is probably inevitable There should be a good demand for breeding stock when normal conditions return. It is important that the loss of acres should not involve too heavy a loss of stock. Every acre must be made to carry more.

(3) The shortage of imported feeding-stuffs is likely to continue. No improvement in methods of distribution can make two tons of cake go as far as three. Two-thirds of normal supplies is probably as much as we shall have ships to bring. Food of higher quality both from pastures and from hay crops is very necessary if a profitable level of stock nutrition is to be maintained.

(4) The fertility which is stored by a good ley will be more easily cashed. Oats are wanted again, and the demand for potatoes should increase.

(5) Finally, if low farming has paid in a period of over-abundance and glutted markets, high farming should pay in a period of scarcity. It is unlikely that there will be a glut of agricultural produce until some two or three years after peace. There is reasonable security for a moderately long-term policy of higher farming.

Let us now turn to some of the difficulties and dangers involved in war-time farming and some of the mistakes that may perhaps be made.

One risk that we all see is that the land, under an increased proportion of corn crops, may " lose heart " in the sense that it will be depleted of organic matter. We all know that this kind of damage can only slowly be made good, and that when deterioration has gone too far, the ley fails to perform its function of restoration. Sir George Stapledon has during the past three years carried on a series of demonstrations in the making and re-making of pastures. Two striking lessons have come out of these demonstrations. The one is that a good new sward can be very easily and cheaply made to replace a bad old sward. If we take a field of old bent, etc., turn the turf upside down, consolidate, slag, scratch a tilth and sow a good grass-seeds mixture we can gener-

ally create a good pasture in, say, ten weeks. A marked contrast is provided by the trials on what Sir George Stapledon calls "plough-sick" land. There is a good deal of this in the South—light arable land that has been ploughed and cropped continuously with too little stock and no ley, so that there is a lack of organic matter. Here there have been many failures. The grasses never establish themselves from seed. We must, then, avoid "corning the land to death." We shall do better to shorten our leys rather than do away with them altogether—sacrifice the fourth year of a four-year ley or the third year of a three-year ley, but stick to the principle of alternate husbandry. I hope that this aspect of the matter will not be forgotten by those concerned with supplies. There will be, or should be, no decline in the demand for grass and clover seeds on account of the increased arable acreage. Steps should be taken to maintain supplies of seeds.

Again we must try to avoid the evils of overstocking as far as possible. We have and shall have fewer acres of grass and smaller supplies of supplements such as lamb foods and feeding cakes. We must try to help out the grass with other things. A rather bigger breadth of roots will prevent the too heavy punishment of sheep pastures in spring. Rape will provide a fattening food for the increased numbers of lambs that will remain for autumn feeding. A bigger breadth of roots is required to balance the larger acreage of grain, to keep the land clean, and to help out the grassland. There is real value in the root crop under war conditions, for an acre of roots will produce twice as much food as an acre of grass or grain.

Thirdly, waste of pasture herbage should be avoided. It is not unusual after rain in summer to find fields, even on well-managed farms, that have more herbage than is good for the stock, and where a good deal is being trodden and wasted. The sward deteriorates as a result of the overtopping of the white clover. Aftermaths with a rank growth of red clover are often poorly utilised; the sward is damaged, and in many cases half the clover is wasted. This superabundance could often be used by netting the lambs over the field by instalments, and cutting the unwanted area for molassed silage. Even with fields that have been grazed, the clearing of a field or two in July would give a mowable crop by September and a stack of silage could be laid by, with great benefit to the sward.

But my task is not to go into such details. I think it is most opportune to hold a grassland conference in these times. The tendency is to emphasise arable crops, and especially the grain crop, and we must take care that the farmer does not forget his grassland. In a real sense grass farming is more important, and not less so in time of war.

THE STOCKING OF HILL GRAZINGS.

Sir JOHN MILNE HOME

I HAVE been asked to speak on the stocking of hill grazings. This is a sufficiently wide title to cover a great deal of ground, and I must be careful not to encroach upon other speakers' subjects.

A good deal of valuable information has recently been published regarding the improvement of grassland by cultural and other methods, and there is undoubtedly much more widespread interest in the subject than existed even a few years ago. That is all to the good, but it is more necessary to-day than ever before to apply such new knowledge to the utmost possible extent.

For what purpose is the herbage, the plant growth, of our hill pastures produced? That seems to be an extremely simple question, but it is just as well to put it. It may be answered in different ways, but the shortest answer is, I think: "In order to graze the pasture with animals useful for human food." Here at once arises the need for skill in management and the proper use of different kinds of stock. Even if hill pastures have been greatly improved, the effort will be wasted, and the benefit not fully realised or transformed into a farming profit, unless correct grazing and stock management follow. But grazing alone, however skilful, on deteriorated pastures cannot produce successful results. I wish to stress this point at the outset.

Sheep are at present the predominating stock on hill grazings, and are likely to remain so. There are hill farms where sheep are the only stock that can be carried. The land for various reasons is not suited for cattle.

Dealing in the first place with sheep only, it is important to consider the variations in carrying capacity of hill land. In making such comparisons it is necessary to know whether the system of management is similar. A farm where the ewe hoggs are home wintered may at the keeling time have the same number of sheep on the stock statement as a farm where the ewe hoggs are sent away for wintering. But the first farm is carrying a heavier stock between November and April, a period which includes those months when keep is most scarce.

The variations in carrying capacity are wide. A good hill farm in the South of Scotland, where the hoggs can be home wintered without difficulty, may have a stock of one sheep to 1½ acre. Other farms, which are perhaps high-lying and have a considerable area of peat, may only carry one sheep to 2½ or 3 acres, and even so the ewe hoggs may have to be sent away for wintering.

The first of these classes of farms will provide something like

45 to 50 head of saleable sheep per 100 acres in each year, while on the second the number may fall as low as 20. By "saleable sheep" I means lambs, draft ewes and cast rams sold, less any sheep bought in—only rams as a rule.

I would like to give one other set of figures. In studying the records and accounts of a great many sheep farms, I have always felt considerable difficulty in arriving at what might be termed a common denominator for the purpose of comparison. There are many points to consider—the death-rate among ewe hoggs; the death-rate among the older sheep; the percentage of lambs at the end of lambing; the death-rate among lambs between Whitsunday and the lamb sales. I have, in recent years, worked out as a basis of comparison a ratio or percentage which does, I think, give the information which we want to get. Take the total number of sheep on the farm at the keeling count, or say at 1st November. Then take the total number of sheep sold during the year, less purchases, and add or deduct any increase or decrease in the total number at 1st November following. The ratio of the latter number to the former will be something between 40 and 65 per 100 for most farms in the South of Scotland. I am not, of course, taking park sheep into account.

A hirsel of 600 sheep on a sound hill farm with a percentage of lambs as high as 90, with a moderate death-rate, might one year with another produce 380 saleable sheep (lambs, draft ewes and cast tups). This would give a ratio or percentage of about 63 relative to the 1st November figure.

Now take the second- or third-rate hill farm where the percentage of lambs may fall as low as 70 or less, and where the death-rate among the rough sheep is relatively high. In this case the average produce of saleable sheep would probably not exceed 240, or a ratio of 40 to the 1st November figure.

Another method of comparison, although less exact, is the estimated production of wool and live weight of sheep sold calculated per acre.

The wool will be found on a good farm to be equivalent to something like 2½ lb. per acre, and the live weight of sheep sold to be between 20 and 24 lb. per acre. On the inferior hill farms the production of wool may fall to 1½ lb. per acre, and the live weight of the sheep sold to 10-15 lb. per acre.

I have worked out this method of comparing one hill farm with another because the ultimate test of the value of a sheep stock to produce a profit depends (apart from prices) on the number of saleable sheep and the amount of wool which the particular farm will produce, one year with another.

Farms of the first type, which we may call Class I., showing a ratio of 60 and over, if carefully and skilfully managed, should

afford a reasonable profit, including a return in interest on capital, assuming prices for stock and wool to be on a fair basis.

The next type, which may be termed Class II., would fall between the ratios of 50 and 60. Most of the better sheep farms in Dumfries and Galloway would fall into this category. Even with the most skilful management these farms have not left an adequate profit in recent years, although they may not have sustained a loss.

The next type, which we will term Class III., showing a ratio below 50 and perhaps as low as 40, is unfortunately not uncommon in the south-west. In recent years a holding of this type must have made a loss, even at a very low rent, and has ceased to be an economic proposition.

The main reason is that the farms in Class III. not only have largely diminished returns, but in most cases have higher working expenses than the Class I. farm, more particularly on account of wintering.

I have digressed to some extent to go into these points, because they are important for a full understanding of the problems for the consideration of which this conference has been called.

We have to consider what can be done in order:—

(*a*) To maintain the fertility and the carrying capacity of the Class I. farms, and perhaps even to improve them still further.

(*b*) Not merely to maintain, but necessarily to improve the fertility and carrying capacity of farms of Classes II. and III. It is this type of hill grazing that must be improved, or it will sooner or later cease to carry any sheep stock at all.

There has perhaps been a tendency in the past, among sheep farmers, to underrate the value of the assistance which is to be derived from research work and from trials made by the Agricultural Colleges in dealing with those difficult and perplexing problems which confront us to-day.

This conference, although necessarily for a somewhat limited circle, will, I feel sure, serve a valuable purpose in focussing most of the knowledge and experience of those who have been paying special attention to these problems. I would like to see all that knowledge pooled and made known as widely as possible to stock farmers and also to shepherds. I believe that a thorough investigation of the conditions existing on any individual hill farm mght produce valuable guidance which could be put into practice to such extent as the farmer might be able to afford.

I will turn now to the question of cattle on the hill farm. An examination of old records will usually show that many farms, now almost exclusively under sheep, at one time carried a fairly large head of cattle as well. Why was this dual method of grazing gradually abandoned? There may be various reasons, but I think that the main cause is probably the fact that when prices

were low and money was scarce cattle could be cashed, whereas the permanent breeding stock of sheep could not be cashed without bringing down the whole system of management.

In the Tenth Economic Report upon Scottish Farming issued by the Department there are some instructive figures with regard to sheep farms. I deal at the moment only with what those tables show regarding cattle on these farms.

In Group 13, which comprises nine farms in the south-east of Scotland, the average size of holding is 2,805 acres. The number of cattle purchased was 7, and the number of cattle sold was 15. In Group 20, which comprises 29 farms in the west and south-west, of an average size of 2,918 acres, the average number of cattle purchased was 8, and the average number sold was 13. The numbers of cattle at the opening valuation at the commencement of the year were 29 in Group 13 and 16 in Group 20.

These statistics are striking, and demand our most serious consideration. They indicate that, apart from farmers' and shepherds' cows kept for the supply of household milk and butter, practically no cattle are reared or summered. The production in live weight is no more than a pound or two per acre.

The arguments against cattle on farms of this type are mainly that they do harm to the sheep grazing and to the "winter meat" for sheep; also that cattle tramp in the open drains. Neither reason is very convincing. Another reason, which is not so often stated, but is nevertheless real, is lack of capital to put on a good head of cattle.

It is true that cattle tread in drains, and it is necessary to attend to the regular cleaning of drains on ground where cattle are kept. The extra cost is not large. The other objection, that cattle interfere with the sheep grazing, and especially the winter meat, is only true if the cattle grazing is unrestricted.

I cannot help thinking that a hundred years ago, when cattle were more numerous on hill land, they were most probably herded, that is a boy or an old man remained with the cattle all day and kept them on the ground they were intended to graze We cannot afford to pay for that kind of herding to-day, but there is a good substitute in the cattle fence, consisting of a single barb wire, which can be cheaply erected.

By grazing cattle on suitable ground, especially that where molinia grows, a very great improvement in the quality of the pasture can be made, and the pasture will be improved for the sheep. A cattle fence need not interfere in any way with the rake of the sheep.

Land that has been grazed bare and kept bare by the combined grazing of sheep and cattle is brought into a condition where improvement with lime and phosphates, if that is possible, can be much more easily and effectively carried out.

Another objection often raised against cattle is that it does not pay to purchase cattle in the spring for summer grazing, and then sell the cattle in the autumn. There is truth in this. In some seasons a fair profit can be realised between the buying and the selling price, but often it is not so. The best stock for such ground is usually the breeding cow of the Highland or Galloway breed, or else the Shorthorn and Highland cross and the Bluegrey. But the keeping of a permanent breeding stock means winter keep, and this again raises a difficult problem on many sheep farms. Where, however, hay or silage can be made, the wintering of the cows is not an insuperable difficulty. It might well become a routine part of the management of many a hill farm.

To what extent can cattle be introduced on hill farms? Each place requires special study before this question can be answered. Speaking in general terms, I see no reason why many of such holdings should not carry one cow to every 20 or 30 acres, the calves being sold at the end of October or early November. If this is possible, we can see what a very important bearing it has upon increased production from the vast area of hill land in Scotland.

I have already referred to a typical hirsel of 1,200 acres carrying 600 sheep, producing 380 saleable sheep from a Class I. farm and 240 saleable sheep from a Class III. farm. If, in the latter case, 40 cows can be kept, which I do not look upon as at all excessive in many cases, then it should be possible to sell off something like 32 calves each autumn, keeping a few heifer calves for stock. There would also be a few old cows to dispose of each year. The gross sales would be doubled, and there is no reason why the number of saleable sheep should not be increased, even although the permanent ewe stock remained at the same number. Such results could not, of course, be accomplished without some improvement of the lower ground by the various means which have been outlined by other speakers.

In conclusion, I would submit for your consideration and criticism the following points:—

(1) Hill sheep farming in Scotland has reached a critical point—less critical in the case of the best farms, but very critical in the case of the Class II. and Class III. farms.

(2) The reasons for this state of affairs do not lie wholly in prices or in the increase in labour and other costs. They are more deep-seated, and are connected with the gradual loss of fertility and productiveness which has been operating over long periods, and which are only now becoming fully realised.

(3) The best sheep farms may carry on for some time, but the Class III. farms, representing the 40 to 50 ratio to which I referred, cannot possibly do so. If retained for sheep only, they will gradually cease to carry a stock at all.

(4) The production of meat and wool from sheep farms, even the good ones, is low, and from the inferior farms it is deplorably low. An increase in production is urgently necessary, not merely in order that an economic return may be obtained, but on the broader grounds of national interest and the demand for greater food production in our own country.

(5) Production from sheep alone may be increased on good and inferior farms, especially the latter, by methods which have been dealt with by other speakers, and which I do no more than name—bracken cutting; drainage; the use of minerals; the application of lime and phosphates on suitable areas; re-seeding; hogg wintering where necessary; better records regarding causes of death; fuller use of the results of research; and systematic and careful burning of heather and grass.

(6) On some farms increased production may have to be restricted to the methods just mentioned, but in the great majority of cases the introduction of cattle, or a substantial increase in the numbers of cattle already carried, affords the most promising line for attaining prosperity in the industry and for increased food production.

(7) It is insufficient to put on cattle without cattle fences, for the reason that cattle will require to be kept only on certain areas of land, mainly aira, molinia and bracken areas. Cattle fences should be erected after careful study of the ground, and not in any haphazard way because a short and convenient line suggests itself. Such fences, when erected, must be carefully maintained. The line of fencing need not, however, be considered a permanency. Experience may suggest alteration from time to time.

(8) The size of cattle enclosures may vary, but generally speaking the best results are likely to be got when they are between 50 and 100 acres. It is desirable that sheep should be able to pass freely below the cattle fence, and that the normal grazing of the ground by sheep should not be interfered with. This is important, as the cattle will usually be grazing on the "infall" of the respective cuts.

(9) While summering cattle need not be excluded as one method of improvement, it is on a breeding stock of cows that reliance must be mainly placed. This in turn means additional meadow ground enclosed against sheep as well as cattle for the production of hay or silage.

(10) For such increased production considerable additional capital will be required. The capital invested in the farms to which I have referred, as given in the Tenth Economic Report, represents about £2 per acre in the south-east group, and no more than 22s. per acre in the west and south-west group. It might well be that in the latter case the capital should be brought up to

£2 per acre. Ways and means of doing this would have to be carefully studied, so that any credits given should be sufficiently safeguarded.

(11) It may be objected that the adoption of such methods on hill farms throughout Scotland would result in throwing upon the market thousands of calves and young store cattle in the autumn and early winter, and that it would be difficult to find buyers to winter the cattle. This would be quite a relevant objection if the change were going to be brought about in one or two years, but it will, in fact, be slow and gradual, and there is no reason why market conditions and the methods of wintering on the lower ground should not gradually adapt themselves to the supply of store cattle available. It might eventually lead to a decrease in the import of store cattle, a result which there would be no particular reason to deplore.

(12) If agricultural opinion, especially those sections more directly connected with sheep farming, the governing bodies and the staffs of the Colleges and Research Institutes are satisfied that development along the lines indicated is desirable and necessary, then it will be possible to ask the Department of Agriculture for Scotland, subject to Government approval of the policy, to devise the necessary administrative methods in order actively to carry out these developments, which I personally believe are practical and will be of the greatest national benefit to a considerable section of the rural population.

ENSILAGE AND GRASS DRYING.

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THERE is no doubt that under existing conditions the main need of agriculture is foods rich in starch equivalent. There is still, however, a deficiency of foods rich in protein of some magnitude if it is assumed that our existing head of stock is to be maintained. There will always be a large supply of oil-seed residues, the so-called oilcakes, because of the need for fats for human consumption and other necessary purposes. In addition to this we used to import about three-quarters of a million tons of oil-cake or meal as such, and this will have to be made good so far as possible on the farm.

Of the foods normally grown, beans, peas, marrow-stem kale, good seeds hay, good dried grass and high-quality grass silage are the only ones which have the correct balance between digestible protein and starch equivalent to replace the oilcake-cereals mixtures of practice. The first four come primarily from the arable areas, thus falling outside the scope of the present discussion, and no emphasis is needed in the case of good seeds hay. It should, however, be noted in passing that it must be *good* seeds hay, cut fairly early from a good mixture and made well without undue losses during haymaking.

Meadow hay and poor seeds hay cannot, in view of their composition and digestibility, be regarded as more than maintenance foods, and will not replace the cakes which are so widely used to-day This is not to decry good meadow hay, which has a place to fill, and an important one at that, in the feeding of live stock. Even the best of such hays are low in protein and never of really high digestibility. The difficulty is, of course, that good haymaking weather coincides with the time at which the crop is at an advanced stage of maturity. To get the necessary protein it is essential to cut the grass when it is much younger than the hay stage.

Very often the farmer is exhorted to cut early for hay. There is a limit to this, and it is set by the weather; frequently it is not possible to "cure" the hay properly at a time early enough to guarantee that the crop is appreciably richer in feeding value than at the normal time for making hay. There is, in addition, the factor of yield. Bulk of hay per acre is of greater importance to-day, though it should not be obtained by allowing the crop to go beyond the optimum stage. It seems to me essential to impress on the mind the need for the production both of hay and of more concentrated materials on the farm. Good hay is an essential, and should not be considered as a competitor with good dried grass or grass silage, but as a complementary food.

In the artificial drying of grassland herbage and in ensilage, every effort should be made to use the crop at an early stage of growth, while it is rich in protein and of high digestibility.

Let us deal first with artificial drying. Here is a process which, so far as losses are concerned, approaches the ideal. It is theoretically the most efficient of all conservation processes, but in practice it has not been such an unquestioned success; the management of the grassland has fallen far short of what is necessary to produce a standard material from the dryer. Thus, of the total output of dried grass in the years 1936 to 1938, according to analyses carried out at different advisory centres only 21 per cent. were in Grade I. which contains 17 per cent. or more of crude protein, 32 per cent. lay between 14 and 17, 29 per cent. between 12 and 14, and 10 per cent. was classed as super hay with less than 12 per cent. of crude protein. Of these types of dried grass it is only that of the first grade that can be looked upon as a direct substitute for cake mixtures. The second grade will approach nearly to this level, but should really be regarded as a material to replace hay and concentrates, whilst the third grade and super hay replace hay alone.

Much has been written, and rightly so, of the good effect of dried grass upon health of animals, but it must be remembered that equally good results are also possible from marrow-stem kale or silage of good quality.

To get the best results from artificially dried grass, a system of grading, either by analysis or by inspection, is essential. The dividing line between the first two grades is difficult to fix, but the third grade and super hay can easily be separated from the first two grades and from each other. At the present time, every effort should be made to produce dried grass of the first two grades throughout the greater part of the year. The management must be such that the grass does not get away from the dryer in mid-season. The combination of silage and artificial drying is most helpful in this regard and will prevent the surplus growth in early summer from becoming unmanageable and so hampering the dryer. The use of suitable seeds mixtures will also assist considerably in obtaining material which is of the correct type for drying to make a high-quality product.

Every effort should also be made to work existing dryers to their full capacity, otherwise both their economic and national efficiency will suffer.

A great advantage of dried grass is its portability and the fact that under normal conditions it will store well for considerable periods.

The most common criticisms levelled against present-day driers are their low output and the high capital cost per unit output. These do not include the disappointment which has been felt at the

low average crude protein content of the material marketed and produced by the average dryer. As has been suggested above, this is primarily due to the management of the herbage and not to the dryer. It is avoidable, as can be seen from the experience of one farmer in England who was able to produce 70 per cent. of Grade I. grass.

The greatest disadvantage seems to me to be the area of grass which must be made available if the dryer is to run continuously at full capacity. The annual output of a dryer of the so-called farmer's type is of the order of 300 tons in the season, and this means that the equivalent of some 100 to 150 acres of grassland must be set free from grazing if this quantity is to be obtained. This assumes a seasonal yield of 2-3 tons of dry matter per acre. In practice the normal seasonal fluctuations will increase the area which will have to be cut over, but it is quite clear that grass drying with the present-day dryers is applicable only to the very large farm or to such areas as aerodromes.

Before leaving the subject of dried grass it is of interest to consider briefly its feeding value. Artificially dried grass of Grade I., clover, and lucerne are all foods balanced for milk production, and 4¼, 5 and 5 lb. respectively will replace 3¼ lb. of so-called dairy cube or meal made up of oil-seed residues and cereals, sufficient for the production of one gallon of milk. Dried grass of the second grade fed at the rate of 4½ lb. will be equal to all the above in starch equivalent, but will be somewhat deficient in protein, though it may be used in this way in an emergency. An allowance of 5 lb. would give adequate digestible protein, but the ration would be rather high in starch equivalent, so an average of 4¾ lb. is needed to replace 3¼ lb. of cube. Grass of Grade III. and super hay will replace good meadow hay, and 2¼ and 2½ lb. respectively are equal in feeding value to 4¼ lb. of hay, which is roughly sufficient for the maintenance of a unit of 2 cwt. of live weight.

Enough has been written of the vitamin and mineral contents of good dried grass, and these aspects can be dismissed briefly by saying that they add appreciably to the value of the product for feeding and are, therefore, of considerable importance. It should not be suggested that such attributes outweigh the value of dried grass as a source of starch equivalent and protein.

There is no doubt that dried grass will produce the results in practice which would be expected from its composition. The modern dryer too is an efficient machine and will not affect the feeding value of the crop to any appreciable extent. Some of the carotene may disappear, but the loss here is not of any practical importance, and other feeding losses should not exceed five per cent. In addition, the modern dryer is foolproof, and will work day in and day out without break-downs.

It is the material supplied to the dryer that will determine the value of the whole process of artificial drying. As to the cost of dried grass, the present economic picture is a very different one, and every existing dryer should be so managed that it is producing the maximum amount of dried material of the highest possible protein content. The process, whilst it may be of great value on the really large farm, is not suitable as yet for the great majority of farmers.

For the latter, ensilage would undoubtedly be the most practicable way of increasing the protein-rich foods on the farm. There is such a definite shortage of starchy foods, both for human beings and for live stock, that the arable land will not contribute much more to the protein foods supply than it does at the present time, and the grassland will have to do it.

It is at once obvious that one cannot look to hay, except for that obtained from good leys. Ensilage of young grass is the only possibility, and our modern knowledge of the process is such that a good-quality material can always be produced from such material.

Past experience has led the farmer to look on silage as a substitute for hay, and he considers it as a roughage. This is substantially true of the silage made from arable crops such as oats and vetches. They have generally been cut when the oats are in the milk stage and the legumes are showing pods. This was essential if good silage was to be made, because it is then that the crop contains sufficient carbohydrates for the necessary fermentation to take place. The product was fairly rich in protein, but not more so than really good hay, though somewhat better than average meadow hay. Maize and sunflower silages too are roughages and will not be rich enough in protein to replace any other than hay.

The arable silage crops all called for a fairly heavy expenditure on tower silos and cutting and blowing apparatus, and the costs of growing were high, so that the process fell largely out of favour.

Modern work on ensilage has concentrated more on grassland herbage and earlier cutting, using cheaper portable silos.

The underlying principles of silage-making are really simple, and the following two points summarise all of importance. The amount of air in the mass must be controlled by careful packing and the formation of lactic acid must be stimulated if the fermentation is to be of the desired nature.

The first depends upon care in filling, the nature of the container if one is used, and the state of the crop.

The second point, which has been called the stimulation of lactic acid, might be put in another way, since it is the actual acidity which is found in the mass that matters and not the type of acid. Of the organic acids, the only one that will give the necessary degree of acidity is lactic acid; the other fermentations are checked

at a level below that at which the lactic organisms can still work.

To get the lactic acid there must be a sufficient supply of carbohydrates, such as sugar, in the crop. When the crop is young and rich in protein it does not contain enough fermentable material, and a suitable addition must be made. This has led to the molasses process of silage-making, in which ½ to 1 lb. of sugar is added to each 100 lb. of green crop. Since molasses contain about half its weight as sugar, 1 to 2 lb. must be used, and this calls for the addition of 20 to as much as 40 lb. per ton. In general, 20-25 lb. will be quite enough for young grass, 30 lb. where there is a large amount of clover, and as much as 40 lb. for lucerne.

The A.I.V. process which has been so successful in Northern Europe goes one stage further than the molasses process, and directly acidifies the green crop, using a dilute solution of the mineral acids such as hydrochloric and sulphuric. In the United States a great amount of interest has of late been taken in the use of phosphoric acid, especially in phosphate-deficient areas. The amounts added are often less than those advocated in the Finnish A.I.V. process, where the aim is to produce a *p*H of under 4·0 in the mass as quickly as possible.

The acid process gives an excellent silage, and is the best of the modern methods of ensilage, but it has certain disadvantages. The first of these is the difficulty of handling and transporting the strong acids that are needed, and their dilution on the farm. Next, the method of addition is important, since each layer must receive its proper quota, and the crop has to be weighed if this is to be ensured. Finally, the silage contains mineral acids, which have to be neutralised by the addition of suitable mineral mixtures.

The molasses process does not suffer from this disadvantage, since the acidity is due to organic acids which are used in the animal body and, indeed, lactic acid supplies very little less energy than the sugar from which it was made.

We have found that the molasses process does not fall far behind the A.I.V. process and that it can easily be incorporated in everyday practice without any expensive equipment. There is one point in the ensilage process that must be noticed. It always results in a break-down of the true protein, but if the silage is good this does not proceed beyond the stage of amino acids, and these have a value which is identical with that of the original protein. In bad silage the break-down may have proceeded beyond this stage to that of simple bases like ammonia, and here there will have been a distinct loss of feeding value, according to the standards generally accepted. It is as well to note in this connection that it is claimed that ammonium bicarbonate and ammonium acetate have some feeding value according to modern experiments. The loss of feeding value may then not be complete even in a bad sample of silage.

In measuring the value of silage, the digestible crude protein is a fairer basis to take than digestible true protein or even protein equivalent.

Silage made from grassland in May and the very early part of June from young leafy herbage, and again in the autumn, September to as late as December, will contain at least 17 per cent. of crude protein in the dry matter, and is really a watered concentrate which can be used for milk production. Clover silage and lucerne silage also come into this class, and are comparable with artificially dried grass of Grade I.

In practice there are differences in water content, and this is the biggest variant, though experience will enable the farmer to make allowances for this, and a simple measurement, using a baking tin and the ordinary kitchen oven, is possible and well worth while.

In general it may be taken that 20 lb. of molassed grass silage, 25 lb. of clover silage, or 28 lb. of lucerne silage will be equal to 3½ lb. of dairy cubes or meal. Translating this into other units, 6 tons of high quality molassed grass silage will replace 1 ton of a dairy cake. Surplus grass will usually yield some 4 tons per acre, which will give 3 tons of silage. Every two acres of surplus grass cut at the young leafy stage will produce the equivalent of 1 ton of dairy cake, which would almost cater for the needs of two dairy cows over winter, in addition to hay.

A great deal of grass silage has been made at a more advanced stage of growth, often just before the hay stage when the earliest grasses are in flower. This gives a silage which contains 13-15 per cent. of protein in the dry matter and will replace hay, though it is slightly richer in protein. It would be better to concentrate on an earlier cut of silage and let such material go on to hay, unless the weather were unsuitable. At the more advanced stages of growth it is often better to concentrate on haymaking and make use of advances in that process.

Some of the crops cut from grassland herbage have been at a very advanced stage of growth, when the protein is low. Such material gives a silage of low protein content comparable with hay in feeding value. Stack silage often comes in this class, even if made from better grass, because of the difficulty of keeping the temperature down. High temperatures in silage—above 130° F—often lead to marked depression of the digestibility, particularly that of the protein.

The various silages, other than high-quality molassed grass silage, good clover or lucerne silage, are then all more suitable for the replacement of hay somewhat as follows:—

To replace 4½ lb. of average meadow hay 9 lb. of low protein silage will be needed—made at the pre-hay stage—or 11 lb. of

poor grass or stack silage, silage from silage mixtures such as oats and vetches, or maize silage.

The aim, therefore, should be to manage and manure the pastureland in such a way as to produce the greatest amount of keep and ensile all the surplus while it is still young and leafy.

Portable wooden, concrete, or wire and paper silos can be used, and these are erected at the most convenient spot. After the silage has settled, the casing can be removed and used again whenever it is needed. The resultant stack will not have the usual characteristics of stack silage and will keep well, whilst the waste should not exceed 3 to 6 inches, which must be offset against the cost of other silos.

Of course, existing silos and also modified buildings can be used equally well for making good silage.

Of 218 samples of silage examined in our laboratories this winter, 15 per cent. have had over 17 per cent. of crude protein in the dry matter, and another 15 per cent. had between 15 and 17 per cent., while 35 per cent. had less than 10 per cent. This shows clearly that it is possible to produce a watered concentrate by the ensilage process, and this material has been used to replace cake. It shows too that most farmers were still making silage from material of the wrong type if they were aiming at a substitute for concentrates.

Most of the silage has been made on small farms with the ordinary labour during May and the greater part in the autumn. The silos have been filled over a period of a fortnight or so, a little daily. A sufficient area is cut in the morning and led between milkings, and this procedure followed until the silo is filled. The materal packs well in this way, and four tons of grass can be led easily each day. Where, for any reason, it is considerable desirable to carry out any other work, silage-making can be stopped, but this halt should not exceed three days. Sixty to ninety tons of silage can easily be made in this way, and will provide a reserve of fodder for winter use equal to ten to fifteen tons of dairy cubes.

Silage can be fed to all classes of stock, and is quite as suitable for young and fattening cattle and for sheep as for dairy cows. It is too bulky for pigs and poultry, except as a source of vitamin, though it will supply valuable protein.

Good silage, like dried grass, is rich in carotene and, if grown on properly manured land, in mineral matter. Silage can also be made a useful vehicle for the feeding of mineral matter to stock. The mineral matter can be added during the making of the silage, and the only point to observe is that the material used should, so far as possible, be neutral or acid. Where minor elements are to be fed, it is a simple matter to add these to silage and ensure their direct feeding to stock.

It is clear then that silage is a valuable food which can easily

be made with little outlay. A cheap portable silo, molasses, and a watering-can are the most that is needed apart from the ordinary farm equipment. Special cutting apparatus is not at all necessary, though an implement such as the Cutlift is a great advantage. Ensilage may be done slowly by a small staff or more rapidly on larger farms with more labour. Actually slow filling gives the better silage!

Before closing, it is useful to note that ensilage can be used as a means of dealing with other materials which might otherwise have been wasted.

Sugar-beet tops, marrow-stem kale, or surplus potatoes can be ensiled without much difficulty, though the kale must be chopped if the results are to be satisfactory. Potatoes should be steamed if they are to be of the greatest use and make a very valuable silage, particularly useful for the pig. We have also ensiled materials such as bracken with fairly satisfactory results. If cut at an advanced stage, the product was little better than straw in feeding value, on a dry matter basis. Where, however, young bracken was cut and molassed, the dry matter was nearer to hay in starch equivalent, and considerably richer in protein. Great care must be taken with the bracken, as it is easy to spoil the silage by letting it heat too much, when the feeding value will be low.

These notes can do no more than indicate the possibilities of silage, which are many. It is important, both for drying and for ensilage, that the greatest amount of grass should be conserved during the twelve months. The lengthening of the growing season is of paramount importance, and the earlier the cutting begins the greater the output will be. Special mixtures will spring to the mind, and the virtures of Italian rye-grass and of rye itself should not be forgotten in this regard.

At the other end of the season the aftermath, much of which is so often wasted, is one of the best materials for conservation because it is mainly composed of leaf and rich in protein. The yield per acre can always be increased by manuring because in late autumn no fear of checks to growth from drought need arise.

The greater the output per dryer and the more often a silo is filled during the season, the lower the capital cost per ton of the finished article and the less the need for materials which are now becoming difficult to obtain for constructing dryers or silos.

With silage, and on some very large farms dried crops, it should be possible to make good the whole of the deficiency of protein foods, bearing in mind that there will always be a supply of oilseed residues to draw on.

The ruminants are the animals best suited to deal with these foods, and it should not be very difficult to feed such stock entirely on home-grown foods, leaving the imported foods for pigs and poultry.

SOME PRACTICAL EXPERIENCES OF GRASSLAND IMPROVEMENT.

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I WISH to explain at the outset that all my personal experience has been in Lauderdale, and I do not wish to lay down any general rules. I have learned that facts about grasses, clovers and grazings are particular and not general. My comments may be applicable to other areas, but they should be taken as applying only to the Lammermuirs and the south-east Borders. Further, they are made entirely from the point of view of sheep grazing.

I took over my farm in 1901. It comprises 1,000 acres of arable land reclaimed by my father during the preceding fifty years. Its altitude is from 750 to 1,200 feet. It was all secondary land, some very stony, some of blue or yellow clay topped with peat, with some areas of better quality. It was then under a five-course rotation—oats, turnips, oats and seeds, and two years' grass. The seeds mixture used per acre was one bushel of Perennial Rye-grass and half a bushel of Italian Rye-grass with a little Timothy and Cocksfoot, English Red, Dutch White and Alsike Clover. The result was in the first year a forest of windlestraes in summer, with no bottom grazing and no autumn feed to speak of, while in the second year it was worse, and would barely keep one ewe and twins per acre.

I determined to improve this temporary pasture, which if left for a third year was invaded by Holcus and Agrostis, the Rye-grass vanishing rapidly. To avoid repetition I would refer those interested to my articles on "Pasture Improvement on High Land."[1] I began in 1902 with top-dressings of slag, slag plus potash and potash alone, applied in considerable quantities, without any good result so far as I could see, and later trials have confirmed this. I am aware that at Boon, where I helped Dr Gibb in his experiments,[2] slag did produce a marked improvement measured by the "mutton test," but that was on deeper, better soil. There was little *visible* difference. The use of lime shows different results. Several times I have noticed in spring a clear line between a limed strip and the rest. I also found that instead of being exhausted in eight or ten years, an application of two tons per acre of lime to grass often took six years to produce a visible effect. Lime is necessary for the elimination of Agrostis. I have never observed any result from the application of potash in the Lammermuir area, and particularly in Lauderdale. I later

[1] See *Scot. Jour. Agric.* II., 59 (1919) and VIII., 136 (1925)

[2] See *Trans. High and Agric Soc.*, 5th Ser. XVII, 271 (1905); XX., 269 (1908); XXIII., 190 (1911).

began to apply slag to the turnip crop and came to the conclusion that this was the best way to get good grass afterwards. After the Great War I was applying 17 cwt. of slag or 8 to 10 cwt. of mineral phosphates per acre, with the usual nitrogen to the root crop.

My experience convinced me that the best and most economical way to get and maintain good pasture is to plough up the old one and manure the turnip crop with phosphates far beyond its requirements, so that its effects are carried over into the grass. This also increased the yield of grain.

When the price of oats fell about 1924 I altered my rotation to oats, turnips, oats, turnips, oats and seeds, or sometimes on lighter land to turnips twice after lea followed by oats and seeds.

This reduced the acreage of oats, and the course included two turnip crops, each receiving about 13 cwt. per acre of high-grade slag. I have now several fields of grass 8 to 11 years old that stand out for miles as brilliant green, almost perfect pasture, with the much-desired " early bite." The 10-year-old field was hayed in 1937, and has had no manure since the turnip crop in 1929. Where these fields needed lime they got it in small doses. I felt justified in laying out money in these improvements since I had a long lease ahead in 1920. The average tenant has not enough security of tenure to justify such expenditure.

My conclusions on manuring are accordingly :—

(1) Ploughing up is infinitely better than top-dressing, which I found almost useless.

(2) Growing two turnip crops, manuring them heavily with slag or mineral phosphates and sowing out with first-class seeds is the best way.

(3) Lime is essential if the ground requires it; otherwise Agrostis soon appears.

(4) A tenant should watch his legal position in relation to improvements.

I have tried top-dressing for " early bite " but found it of little value. I have not tried such mechanical treatment as cultivating, harrowing, etc., since my land is too stony for implements to work satisfactorily. The improvement effected by mowing at the proper time is very great, whether one removes the cuttings as hay or leaves them. But it is difficult to prevent shooting, as this falls to be done at a very busy season.

Adequate grazing by cattle such as Galloway cows and calves is beneficial in keeping the grass short and preventing shooting. The difficulty is to get the cattle, or having got them to graze them without losing money. The best kind is the Galloway cow wintered out and grazed with her calf.

Along with my manurial experiments I worked steadily at getting better grass mixtures. Up to 1914 few farmers knew any

grass but Rye-grass by sight or even by name, and I had come to the conclusion that the rye-grasses were little better than noxious weeds from the point of view of sheep on the high-lying pastures of my district. Helped by R. H. Elliot's book,[8] I started a series of simple experiments. My first and absolutely essential object was to learn to identify the plants I was dealing with. Then I wished to find out the following things about every plant involved in relation to its behaviour on my own farm and in my own district:—(1) Palatability to different classes of stock; (2) productivity under normal and under more adverse conditions; (3) earliness and seasonal variation; (4) bottoming qualities; (5) longevity or "perennialness"; (6) viability after one year.

Every year I sowed all the pure grasses in strips 20 to 30 yds. long and 5 yds. wide, and sowed the pure clovers across them in similar strips. By 1914 I had a fair amount of knowledge. I carried on when I came home in 1919, and my last plots were sown in 1930.

My general conclusions are:—

(1) *Palatability.*—Cocksfoot, if kept down, is the most palatable grass for sheep, followed by Timothy, the Fescues and the Poas. Yarrow is well liked by sheep, but rejected by cattle. Tall Oat Grass is liked by sheep, but rejected by cattle and horses. Rye-grass is always rejected by sheep if they have any choice. Late Red Clover, especially the Essex type, is well eaten and does not cause scour like Wild White.

(2) *Productivity.*—For hay Rye-grass weighs most heavily in the first year, with Tall Oat Grass about equal. If aftermath is counted, Cocksfoot runs them close. After the first year Cocksfoot was always first, followed closely by Tall Fescue and Tall Oat. Rye-grass was a poor fourth, with Timothy gradually improving until it later exceeded Rye-grass. The Poas were negligible in pure plots, but in mixtures *P. Trivialis* helps the bulk of a pasture or hay crop.

For foggage I put them in this order:—Cocksfoot, Tall Fescue, Tall Oat, Timothy. The rest are of little account.

(3) *Earliness.*—Cocksfoot, the Fescues, Tall Oat and Rye-grass are the earliest. Others turn green as early or earlier, but their actual growth is negligible. For an early bite Cocksfoot is easily first, with Tall and Meadow Fescue following closely. Tall Fescue is the first grass to grow after cutting for hay.

(4) *Bottoming.*—The Fescues are easily first. Tall Fescue suppresses weeds.

(5) *Longevity* varies greatly with environment. Rye-grass has a short life in Lammermuir except on the richest land.

[8] "Agricultural Changes and Laying down Land to Grass," by R. H. Elliot of Clifton Park (Rutherford, Kelso).

(6) *Viability.*—I found that the shorter-lived grasses had the greatest viability. Italian Rye-grass for instance produced about 100 per cent. of plants for seeds sown, whilst the longer-lived real perennial or natural grasses had often a very low viability in practice. Timothy for instance can only be counted on to produce 10 per cent. of plants for seeds sown. This is dealt with in my articles mentioned above.

Before 1914 I had several times a great take of Late Red Clover, but could not be sure of repeating it until I got from an Essex grower a strain far superior to any others. Now we have certified Montgomery and others that are very good. My Essex I find more palatable and more lasting; it grows even into the sixth year, of course in reduced amount.

It is easy to make wrong deductions. Palatability depends on age as well as type, and a sheep will leave old Cocksfoot foggage or aftermath to eat young Rye-grass, etc. Soil, acidity and elevation are important factors. Like should be compared with like—Cocksfoot 6 in. long with other grasses of the same length. I have tried the new strains of Rye-grass and Cocksfoot and find them different, but not worth the extra cost. I have two separate acres sown with Welsh indigenous grasses—Cocksfoot, Timothy, Rye-grass and Red Fescue—which are left uneaten by sheep. I do not decry these strains, but under my conditions they are unpalatable. They might do for Blackfaces on poorer ground; I have yet to try this. I need hardly say that I have the greatest admiration for Sir George Stapledon's work.

The following is taken from my notes of 17th July, 1926, on a six-year-old plot shut up for hay:—

Cocksfoot—too ripe; keeps out weeds and Yorkshire Fog; good crop.

Tall Fescue—good leafy grass; keeps out weeds and Yorkshire Fog.

Timothy—good and leafy; late; has kept out weeds and Fog fairly well; still thick and lasting well.

Tall Oat—good hay grass; not so good for smothering weeds as Cocksfoot and Tall Fescue.

Perennial Rye-grass—not much left surviving; very weedy and full of Yorkshire Fog and Crested Dogstail.

Meadow Fescue—Leafy at bottom; a few weeds. The rest poor and weedy.

I think the quantities of seed usually recommended are too small; 30 lb. (or 10 to 15 million seeds) per acre may do for hay on good land, but it is inadequate for grazing on poor land. On the higher land in Lammermuir we always graze our young grass and hay on older fields. Young grass is worth far more for

feeding lambs than for making hay. To make a decent take we need fully 50 lb. (or 20 million seeds) per acre.

I am also surprised by the advice given to sow Rye-grass on high poor land. Rye-grass plus Wild White gives a pasture that looks green early, but its produce is small, and the Rye-grass, even mixed with clover, is still apt to be left in windlestraes. The maximum sowing of Rye-grass should be 8 to 10 lb. per acre. It is a friend of Holcus and rapidly allows Agrostis a footing, whereas with Cocksfoot as the basic grass these and other weeds are excluded. In my pure plots Cocksfoot and Tall Fescue were always free from weeds, while the Rye-grass plots were rapidly filled with them.

In 1923 I laid down an experiment to determine the best "mate" grasses for Cocksfoot. I found that the Fescues and Cocksfoot and *Poa Trivialis* agreed and complemented one another, and I now base my mixtures on this finding.

(Field now 10 years old)	1930. lb.	1940. lb.	
Perennial Rye-grass	4	6	
Italian Rye-grass	2	–	
Cocksfoot	15	15	(Danish)
Tall Fescue	15	–	
Timothy	3	6	
Meadow Fescue	6	12	
Yarrow	$\frac{1}{6}$	$\frac{1}{6}$	
Crested Dogstail	1	$\frac{1}{4}$	
Poa Trivialis	2	2	
Late Red Clover	4	4	(Montgomery and Essex)
Wild White Clover	$1\frac{1}{2}$	$1\frac{1}{2}$	(Kent 1 lb., New Zealand $\frac{1}{2}$)
Alsike Clover	1	1	
Total	55	48	
Cost about	67s.	56s.	

Rye-grass is sure to grow, and it does help in the first year. Danish Cocksfoot is the earliest, and that counts. In some respects Swedish Late and Akaroa are better, but on balance Danish has the advantage in utility and price.

I usually sow a large proportion of Tall Fescue, but this year the price is high and I am sowing Meadow Fescue instead. Fescue is a great bottomer. Timothy is a good palatable grass; it lasts longer and produces more than most observers think. Crested Dogstail is a small producer but a good stayer and spreader. A little goes a long way, but it is one of the few grasses that can withstand Agrostis in places. Yarrow is liked by sheep and is a

great resister of drought. Alsike is a good producer for two years. Tall Oat is omitted because of cost; it is a good sheep grass.

I have tried re-sowing without cropping, but have not found it very successful. On bad clay, however, where it is almost impossible to take a turnip crop, it is the best course. I advise a sowing out with a thin sowing of oats. This I have done successfully on cold, wet clay. Rape I have not found to be a good nurse crop. I place them in the following order in my experience:—

1. Barley.
2. Oats—Black or Tartarian Type.
3. Oats—strong short-strawed new types.
4. Oats—Potato.
5. Oats—Sandy.
6. Rape.

Sweet Vernal is a better grass than is generally thought. A hundred years ago it was highly esteemed. I have tried it in pure plots. Horses, cattle and sheep ate it, and horses appeared to prefer it to many others. I successfully sowed 2 lb. per acre in a 20-acre field in 1920.

I tried the commercial Foxtail, which comes from Finland, but found it almost useless. I gathered a supply of home indigenous Foxtail and sowed it in one of mv plots. It proved very good—early green, leafy and far superior to the Finnish. So far as I know there is none of this on sale, but it is certainly worth cultivating. The Plant Breeding Station has a stock of this now.

I had noticed the Wild Tare and Pea flourishing on my worst land. In 1924 I had a lot gathered from dry banks as well as from wet clay, and had it tested by Dr Smith. It was a mixture of *Vicia Sepium* and *Lathyrus Pratensis*. The germination is very low—only 14 per cent—and the plot was a complete failure, only one plant resulting from about a quart of seed. These plants are worth further research. They flourish on bad land, are fine leguminous plants, and are liked by stock.

Tall Oat Grass I found to be a good grass, liked by sheep but disliked by cattle and horses.

I have an interesting letter, dated 1789, from my wife's great-great-grand-uncle near Epsom to his brother in Scotland telling him of his pride in his fine white clover. Wild White was apparently known then. Its merits need no comment from me except that the best New Zealand is a bigger plant than the Kentish.

To the question "Does it pay?" I think the answer is that it does.

In 1926 I ploughed a field that was not good grass, and

cropped it with oats-turnips-oats-turnips-oats and seeds. During that rotation it got the following manures per acre:—

Ground Quicklime - - -	1 ton.
Slag 34 per cent. - - -	17 cwt.
Ground Mineral Phosphates 75 per cent.	8 cwt.
Superphosphates 38 per cent. - -	4 cwt.

at a total cost of £7 7s.

The grass seeds cost 67s. Seeds were dear then and I sowed among others 15 lb. of Tall Fescue.

The total cost of manures and seeds was thus £10 4s., for which I got five arable crops and the unexhausted phosphates for the grass. The grass is 10 years old now, at 900 feet, and is as good as could be seen anywhere on the best land at 100 feet.

Another field was a permanent pasture 100 years old, and was as useless as most of these sacrosanct permanent pastures are. Analysis showed 98 per cent. Agrostis, with traces here and there of White Clover. It kept one ewe hogg per acre, and a few horses or cattle, and did them all badly. After negotiations I got permission in a new agreement to plough it. I took one rape, one turnip and one oat crop and sowed out. It cost £7 per acre for manures and grass seed, and the field was transformed from a useless grazing to a fine hay field now seven years old.

Such a transformation as this lasts, except on peat, over cold clay or muirband. There reversion takes place in five or six years. Perhaps subsoiling plus 5 tons of lime per acre would do it, but this expense is too much for a tenant to incur on another's land. The improvement of permanent pasture is not a scheduled improvement under the Agricultural Holdings Acts. Occupying owners have the chance of a lifetime to improve their farms, and many are taking it. With £2 per acre for ploughing up, half the cost of lime, one-fourth of the cost of slag and half the cost of drainage there is the utmost incentive for the improvement of pasture by occupying owners and landlords, and no excuse for having bad pastures.

What I have said may not sound much, but it took me 20 years to find it out by continuous observation and many laborious days spent in sowing, cutting and checking up the plots, assisted by my wife, and it took me another 20 to reap results. I am still learning.

To put this knowledge into operation a tenant must feel secure, and obtaining in 1920 a new lease for 20 years, with breaks in my favour alone, I felt able to go ahead with the large-scale application of the improvement plan. The result is that about 700 acres of pretty useless temporary pasture has been transformed. Where there were acres of Agrostis and Holcus there is now fine pasture entirely clear of these weeds, except in a few patches. For various reasons I have made no experiments since 1930.

THE ERADICATION OF BRACKEN.

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On behalf of the Committee appointed to investigate the methods of eradication of bracken.

FOR a description and illustration of the structure of the bracken plant, with its enormous extent of underground rhizome, we refer you to an article written five years ago.[1] The continuous destruction of the fronds ultimately exhausts this underground store of food, but the process requires time.

I will now review the various instruments and implements used for the destruction of the fronds.

The simplest method of destruction is the use of the ordinary scythe. It is effective but slow and expensive. It may cover from ½ acre to 2 acres a day; the cost per acre thus ranges from 2s. 3d. to 6s. or more.

The *Denny* hand scythe is intended for less skilled persons. Theoretically it is lighter to use than the ordinary scythe, as it does not carry its load, but in practice it is no quicker and perhaps no less exhausting.

The *Aitkenhead* Bracken Eradication Attachment for the Aitkenhead harrow is drawn by a tractor and flattens out the fronds, which are then torn out by the harrow and should be expelled in rolls every few feet.

Nearly all motor machines are of the cutting type, most of them being fitted with a cutter-bar like that of a mowing machine, actuated from the centre or from one end.

The *Allen* Motor Scythe has the cutter-bar worked from the centre and is a dual-purpose machine, suitable also for rushes, verges in policies and " roads " in cereals.

The *Atcoscythe* has the drive at one end of the cutter-bar. In the latest types the motor drives both the bar and the machine. It is the lightest type of dual-purpose machine.

In the *Collins Junior* Power Bracken Cutter, and the *One-Wheel* Bracken Cutter, the " cut " is a slashing and not a clean cut. The cutter is a horizontally placed pair of linked knives and the nose of the machine skids over the surface of the herbage. The " cut " is produced rather by the speed of the slash than by a sharp edge on the knives, so these do not blunt and will withstand many contacts with rocks, etc. The larger machine will tackle anything, but it is heavy to manœuvre on rough ground. The single-wheel lighter model will negotiate slopes of 1 in 3, and will go where a man can walk. Although the cut is smaller the extra mobility

[1] *Scot. Jour. Agric.* XVIII., 121 (Apr. 1935). This article has been reprinted by the Department of Agriculture for Scotland as Leaflet No. 69.

produces not much less work at the end of the day. These machines are not liable to damage from obstructions.

The *Irvine* Bracken and Thistle Cutting Machine is a heavy, robust machine having a side drive to the cutter-bar.

The *Gordon* Bracken Cutter started with a central drive to its cutter-bar. This was apt to collect fronds in front of it, so a side drive was adopted in 1937. In the M'Cormick model of 1938 these are superseded by four vertically whirling chains from two forward driving-wheels.

Of the horse-drawn machines, the simplest is the *Crossley* Bracken and Thistle Cutter, which consists of a V of 8 ft. outside-side length with a knife-edge directed outwards and the whole mounted on low skids. It has to be drawn by long traces and the edge must be kept keen. If these requirements are fulfilled it severs 80 per cent. or more of the fronds.

The *Glaslyn* and *Glaslyn Junior* machines are like a roller in two halves with seven pairs of knife-edges replacing the rim of the roller In the larger machines seven bars between these knives prevent short fronds from being missed, and the weighty machine bumps off one knife-edge on to the next, partially severing the fronds at about 8-inch intervals in its progress.

The Junior machine is in two halves and one of these can be detached for a small horse or pony. The knives should be sharp and long traces are necessary so that on slopes the machines can tilt forward and the chassis form its own sprag.

The *Henderson* Bracken Machine is of a similar type, but nowadays has the road wheels on the top and is fitted with a brake for use on declivities

The *Holt* Bracken Breaker consists of heavy iron bars rotating round simple terminal shackles. All these horse-drawn machines had the great disadvantage that the horse exhausted itself in breasting tall bracken which possibly concealed rabbit-holes, stones, etc. A side-hitching device on the Holt allows the horse to walk in the already bruised bracken.

The *Triangular* Thistle Cutter is similar to the Crossley except that it has a wavy knife-edge.

The choice of any bracken-cutting machine in preference to the scythe is usually a question of covering more ground at less cost.

A motor machine should normally be able to cut a larger area in a day than a horse-drawn implement; but a mechanical machine is more costly to purchase and requires the services of a comparatively skilled man. A skilled man, however, would probably choose some form of work requiring less expenditure of physical effort. Where the skilled man is not available a horse-drawn implement is indicated. In either case the maximum effort must be made to keep the machine in use during the short cutting period by

employing two relays of workers if possible. The cost of cutting bracken depends to a great extent on the incidence of the charge made for depreciation. With a £100 machine 1000 acres can be cut for less than 1s. 6d. per acre, while 50 acres would cost 9s. + per acre. With a £10 machine 600 acres could be cut at 1s. 6d. per acre and 20 acres would cost 3s. 6d. per acre. An idle machine "eats its head off" even though it cannot "eat."

We have for a long time considered that a severed frond, which rapidly dries up and disappears and so does not inhibit grass development, is the ideal. The theory propounded in certain quarters that the prostrate bruised frond "bled" and exhausted the rhizome did not appeal to us when we noted that these fronds often failed to die and apparently were so little injured that they could produce viable spores. The marked superiority of a cutting type of machine over bruising types was shown where, in three years of cutting, an original "crop" of more than 5 lb. per square yard was reduced to 1 lb. by a cutting machine compared with a reduction to 3 lb. by a bruising machine. These results at Castle Semple were said to be so opposed to other findings that in laying down the plots at Touchmollar, Stirling, all the cutting machines were grouped at one end and given what was, if anything, the taller, ranker bracken. After two years' cutting the superiority of the cutting machines was again so clear that at last year's demonstration, Principal Paterson directed attention to this fact.

The bruising machines do reduce tall bracken during the first few years, but thereafter the reduction becomes very much slower.

There is a demand for a horse-drawn cutting machine. The Irving Horse-drawn Bracken and Thistle Cutting Machine is like a mowing-machine but geared to be more satisfactory in bracken.

The makers of the Brenton have not yet accepted the invitation to demonstrate their machine. A Kelso Thistle cutter is of similar type but is apt to choke in tall bracken. In addition there are the Crossley and Triangular Bracken Cutter.

Of the motor-driven cutting machines the Collins is probably the least easily damaged and the one most capable of covering the ground quickly. On test it can do one acre in 26 minutes, but in heavy bracken will possibly not exceed an acre an hour. Especially is this the case in small isolated patches where much time is lost crossing boggy areas between the bracken patches. Here the one-wheel machine scores.

Sooner or later, after prolonged cutting, the density of the bracken covering becomes thinner and the shepherd begins to advise against complete removal of the frond as it shelters the "late bite" from the frost. Even if the tempter is not listened to, there is a waste of time in cutting a few fronds per square yard with a small, slow-speed machine. Hidden rocks and holes and ditches are now visible, so the Collins "Mopper-up" or a

Crossley or Triangular Bracken Cutter behind an old car becomes useful. It is to be hoped other inventors will also enter this field.

In order to discover how long it takes to exterminate bracken by scythe-cutting and how many annual cuttings are profitable, Mr John Wilson laid down experiments in North Argyll in 1935 and he, and later Mr A. G. Malcolm, had the plots cut regularly at weekly intervals from early June for 13 weeks. The scheme is as follows:—The first plot is cut on, say, the first Monday of June and the second plot on the next Monday. On the 6th Monday, in addition to the 6th plot, $\frac{2}{3}$ of the 1st plot are cut for the second time, and on the 11th all the 11th plot, $\frac{2}{3}$ of the 6th plot and $\frac{1}{3}$ of the 1st plot are cut. In this way we get areas cut once, twice and three times. The scheme is still being carried on. From the weights of sample areas of 4 square yards each, left to be harvested and weighed in July 1938, a graph has been prepared which shows that if all the bracken could be cut "at one fell swoop" a date about mid-summer would be suitable. This is impossible, and the next best thing is two cuttings—one early and the other 5-6 weeks later. Three cuttings per annum are certainly quicker but not financially advisable. Where, however, three cuttings were made annually for four years, practically no more bracken exists.[2]

Principal Paterson has demonstrated at the Burg Farm, Mull, that, on suitable soil, a good crop of oats can be grown after only two years' cutting of bracken.

Experiments are being carried out by Dr Bates and the British Rubber Publicity Association for smearing the cut surfaces with weak solutions of sodium chlorate. The scythe and the Allen have been used for this purpose and the makers of the Glaslyn have adopted it for their machines on their own account. Presumably with the former machines to obtain good results a partial drought is necessary.

The methods of spraying and dusting with herbicides (sulphuric acid or sodium chlorate) are possible but unduly expensive except for small areas.

Now and then, and especially in certain seasons, disease (which is rare in bracken) comes along and kills out patches.[3] Bracken on wet soil is most apt to suffer. One cannot help hoping that after the severe frost of the past season bracken living on the marginal bracken land in shallow soil will succumb to disease. One of our research workers—Mr Reid—has shown, however, that while frost may be penetrating 2 ft. in peaty soil or 18″ in a consolidated road, under a dense blanket of bracken-

[2] *Scot. Jour. Agric.*, XXII., 215 (July 1939).
[3] *Scot. Jour. Agric.*, XVII., 297 (July 1934).

litter the frost may only extend a few inches, so we should not hope for too much.

So far, I have been dealing with facts; I will now give possible answers to some questions.

Why does bracken spread?[4]—Several reasons may be suggested:—

(1) Absence over many years of frost-bound soil in winter.

(2) The depreciation of upland grazings by (*a*) over-selective grazing of sole-forming grass components, and (*b*) depletion of manurial ingredients removed in mutton, bone and wool.

(3) Invasion after the burning of too rank heather which could not regenerate from the stool, the subterranean bracken rhizome not having been affected.

(4) Insufficient cutting or disturbance of rhizomes.

(5) The increase of peaty litter in old sites tending to exclude all but acid-loving colonists (heather, birch, rushes, etc.).

Will bracken come back on to areas that have been laboriously and expensively cleared?—Analysis of bracken soils show they are very acid. Dr I. C. Jack's figures for Touchmollar show *p*H values ranging from 3·54 to 4 38, with the majority just over 4·00. Lime requirements are large in all cases. Potash also is significant; it is characteristic of the old bracken areas, possibly through the decay of the old fronds, in which it is markedly present.

Personally, I feel confident that unless the acidity is reduced and the quality of excluding herbage improved a fresh bracken invasion is highly probable. Years of extensive research by teams of agriculturists, chemists, zoologists and bacteriologists, besides botanists, are necessary to give the complete answer to these questions.

Cultural operations with mechanical implements and the flooding of the bases during summer on to such land are lines which should be more fully studied.

From my small investigations into the question of successors to rank bracken, I am inclined to believe that in large bared areas with no ground covering, with few potential colonists as seeds in the soil, and in the absence of grazing animals, rushes in damp soil and birch in better-drained soils are the natural invaders. Where the areas are smaller, heather enters if grazing animals are excluded, but small portions of bracken can again invade and increase.

Can bracken be made made to pay even partially for its own

[4] *Scot Jour. Agric.*, XVII., 59 (January 1934).

destruction?—The following table shows the average composition per cent. of the three substances named:—

	Bracken Rhizome (Hendrick)	Perennial Rye-grass (Green)	Potato Tubers
Protein - -	2·0	2·9	2·1
Oil - - -	1·5	0·7	0·1
Soluble Carbohydrate -	13·0	11·5	19·7
Fibre - - -	6·0	6·2	0·9
Ash - - -	2·5	2·8	1·0
Total Dry Matter -	25·0	24·8	23·8

The composition of bracken rhizome and that of perennial rye-grass are closely comparable, but while the latter can be cut and utilised at once, the former has to be dug up; further, it contains deleterious elements that are cumulatively poisonous.[3] Potatoes are similar in composition except that almost all their carbohydrates are in the form of starch and the proportion of fibre is very small. Whether the poisonous properties of bracken rhizome can be destroyed by roasting, by ensiling, or in some other way, is not yet clear. Certainly the carbohydrates could be fermented for the production of power alcohol, and the fibre converted into bracken board. The feasibility of small local industries is a not impossible dream.

[3] *Scot. Jour. Agric.*, XIX., 247 (July 1936).

THE RESULTS OF SURFACE HARROWING COMPARED WITH THOSE OF PLOUGHING.

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THE early experiments carried out at Cockle Park on pasture improvement by phosphatic top dressings were attended by such striking results, both in the improvement of the botanical character of the herbage and in the live-weight gains made by the sheep on the treated plots, that they attracted widespread attention and stimulated the trial of similar methods over a wide range of different types of soil and pasture.

It very soon became evident, however, that the results obtained at Cockle Park could not always be reproduced under the very different conditions prevailing elsewhere. Thus, for example, a series of trials was laid down at several centres by the Highland and Agricultural Society in 1901 and continued till 1911. These trials were conducted upon pastures regarded as typical of much of the poor hill land of Scotland. In the final report, published in the Society's *Transactions* for 1911, it was recorded that although the application of slag resulted in every case in an improvement in the pasture, as measured by live-weight increase, the results were nothing like so striking as those obtained at Cockle Park, and, moreover, they were much slower in appearing. On the average, three to four years elapsed before sufficient result was obtained to pay for the slag. This was attributed, at least in part, to the presence of a more or less dense mat of imperfectly decayed vegetation on the surface of the soil, which delayed the penetration of the manure and inhibited the rapid spread of wild white clover.

It was a natural consequence of such experiences that endeavours should be made to assist and speed up the improvement by partial destruction of the mat by mechanical means. It was hoped that in this way the penetration of manures would be improved, while at the same time the opportunity might be taken to introduce the seeds of better grazing species, especially those of wild white clover where that plant was deficient.

A method of improving badly matted grassland, which had been successfully used in East Lancashire, was described by J. Orr in an article in the *Journal of the Ministry of Agriculture*, Vol. XXXV., April 1928. Four processes were involved:—

(1) Lime was applied in autumn (2 tons ground limestone per acre).

(2) Mineral phosphate was applied in winter (5 cwt. per acre).

(3) In spring, when rainfall was heavy, the field was freely harrowed with a Parmiter harrow. The number of times this operation was repeated is not stated, but the effect was to scratch the surface sufficiently to form a very shallow seed-bed.

(4) In April wild white clover was sown (1½ lb. per acre) and harrowed in.

The result of this treatment was the successful establishment of wild white clover, without immediate destruction of the mat or any other radical alteration in the herbage.

Several trials of harrowing methods have been carried out in the East of Scotland College area during recent years. In the winter of 1932 an experiment was carried out on the hill pasture at Boghall, four implements being tested, and the plots afterwards dressed with phosphatic manures and seeded with cleanings. The cleanings contained about 50 per cent. perennial rye-grass, 25 per cent. Yorkshire fog and some wild white clover, crested dogstail and other species, and were sown in the middle of May at one cwt. per acre. The original vegetation was a roughish herbage consisting mainly of *Nardus* and *Agrostis*. No lime was used in this trial.

The result was fairly successful but by no means spectacular. The best result was secured on a plot which had been cultivated several times with a disk harrow, and afterwards manured with slag at 16 cwt. per acre. This implement cultivated to a depth of about 2 in. and did not leave a great deal of loose rubbish on the surface. It did expose a fair amount of bare soil and provided in such places a seed-bed in which Yorkshire fog established itself quite successfully from seed. On the other hand, perennial rye-grass and wild white clover did not establish themselves very well. The sheep evidently found the treated area attractive for they spent a good deal of time on the ground, and the plots became well grazed and much fresher than the surrounding area. It required about four or five turns of the disk harrow, however, to get this result.

A number of experiments on grassland improvement were begun in the College area in 1937. The plan of these was similar throughout, an area of poor pasture being limed and treated with potassic mineral phosphate—the rates depending on soil conditions—and cultivated two or three times with a " Hankmo " harrow. In most cases, seed cleanings, consisting mainly of Yorkshire fog, perennial rye-grass and wild white clover, were sown on the treated area. The results of these trials were very varied, but only in rare cases could they be described as striking. The best result was secured at one centre, where the original vegetation consisted of a very poor stunted type of heather of an open habit, together with small amounts of *Nardus*, stool bent, sedges, etc.

The surface soil was peaty to a depth of about 6 inches and remained in a moist condition for a long period in spring. Under such circumstances, it was comparatively easy to prepare a moderately good seed-bed by surface harrowing. A good deal of bare soil was exposed and the high moisture content favoured rapid germination. Moreover, the native vegetation was of a slow-growing character and once it had been torn up by the harrows it did not rapidly recover. Conditions were thus very favourable for the establishment of the sown species and a good take was secured, except in parts of the area that had become too dry by the time of sowing. Yorkshire fog became the dominant grass, with a good deal of white clover and some perennial rye-grass, although the latter did not do so well as the Yorkshire fog. The experiment could be described as very successful.

This, however, was not the case everywhere. Where the original vegetation was of a grassy type—dominated by *Nardus, Agrostis* or fine-leaved fescues, the result of the harrowing operation was much less successful. Less bare ground was exposed in harrowing and the turf that was torn up tended to dry out, forming a very unfavourable substratum for the germination of seeds and the survival of seedlings. In addition to this, the native vegetation was of a much more rapidly growing character than that of the heathery centre just described. It recovered very rapidly after harrowing, and even if the seeds that were sown did succeed in becoming established, the seedlings were in great danger of being choked out by the vigorous growth of the old grass. Speaking generally, it could be said that, while on the heathery type of vegetation harrowing, coupled with appropriate manurial treatment and the sowing of seeds, resulted in a marked and radical improvement, on the grassy types the only effect appeared to be to speed up in some cases the improvement which would in any case have followed the manurial treatment. In the majority of cases the seeds sown upon the harrowed surface were more or less wasted.

In the following year it was decided to try the effect of ploughing out some of these grassy pastures and re-seeding directly to grass, various treatments in the way of liming and manuring being applied. For comparison with the ploughed section other areas alongside were given similar manurial treatment, one of them being harrowed and sown with seed cleanings, the other receiving no treatment except the manures.

These trials largely confirmed those of the previous year as far as the effect of harrowing is concerned. A certain amount of improvement was shown in somewhat better grazing of the harrowed area, but the establishment of seedlings from the sown seed was not very striking, and in particular there was very little establishment of wild white clover to be seen. Yorkshire fog

did somewhat better. The ploughed-up section on the other hand showed a completely different aspect, and there proved to be no difficulty in getting a highly successful establishment of the sown grasses and clovers provided certain precautions were taken. Briefly these were :—

(1) The old turf was completely buried in ploughing, so that the young seeds did not have to compete with a strong growth of the original herbage. This was secured by ploughing with a broad flat furrow inverted as completely as possible. A cocked-up furrow is not suitable because there is great danger of the old grass growing up again between the furrows. Apart from this, a flat, well inverted furrow makes consolidation much easier, and a well consolidated seed-bed is of the greatest importance for the successful establishment of seedlings.

(2) The second point concerns the manurial treatment of the soil. These old pasture soils are almost invariably deficient in phosphates and lime, and it is a waste of time and money to plough out and re-seed without making good the deficiencies. Generally speaking we have found that in the majority of cases phosphate is most likely to be the most serious deficiency. If the phosphatic dressing is omitted the effect is seen at a very early stage after sowing, in the poorer growth of the seedlings. Lime, unless it is extremely deficient, does not usually show its effect so early as phosphate, but the effect appears in due course. Potash has been found to show an effect in some cases, although this is not usually seen until the second year.

Provided the ploughing has been properly carried out and the manurial deficiencies made good, our trials show that very successful takes of seeds can be secured even on extremely poor soils. One or two difficulties may be encountered in some cases. Although complete burial gets rid of the old turf, it may also have the effect of bringing to the surface large numbers of viable seeds, and, particularly where the land has been under cultivation within comparatively recent years, there may be large numbers of seeds of annual weeds like spurrey, redshank and day-nettles. These quick-growing plants, if present in large quantity, are liable to have a very bad effect on the stand of young grass unless they are kept in check. Grazing and treading by stock will help to check them, especially when they are fairly small, but if they get too strong they should be cut over with a mower. Another way of dealing with land which is full of weed seeds would be to delay the sowing of the grass seeds till late July or August. This would give an opportunity of attacking the weeds during the growing season by surface cultivation.

Certain perennial weeds may also prove troublesome. The only ones that have given us any trouble in the early stages are the creeping thistle and creeping soft grass (*Holcus mollis*). The

thistle can of course be dealt with by cutting, but *Holcus* is not so easy to dispose of in this way, and if it is at all abundant it is doubtful whether it is wise to attempt to re-seed without first getting rid of the worst of it.

Summing up:—Our experience of surface harrowing has been that although it has in some cases accelerated the rate of improvement to some extent, it has not by itself, except in rather special circumstances, resulted in any very radical improvement of the pasture.

On the other hand, ploughing and re-seeding, if properly carried out and supported by adequate manurial treatment, has resulted in very great improvement. It has two advantages over surface harrowing, firstly that it disposes of the mat completely, and secondly that it enables the inferior grasses which are always dominant on poor pastures to be destroyed and a fresh start to be made with good grasses and clovers. The initial cost of the ploughing method is of course higher than that of harrowing, but the results are very much better, and if the £2 per acre ploughing subsidy is made available in respect of land re-seeded straight to grass it will go at least part of the way to level down the cost.

At the present time no one will question the importance of securing the maximum productivity of grassland, and our experience as far as it goes certainly indicates that in the great majority of cases the best and quickest method of doing this is to plough and re-seed.

CULTURAL OPERATIONS IN THE ESTABLISHMENT OF PERMANENT PASTURES.

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FOR many years now I have been specially interested in the improvement of permanent pasture. I came in for a good deal of criticism because I advocated tackling land which was absolutely run out and reclaiming it. My view was that it was our business to learn how to go about the job so that should the occasion ever arise we should be in a position to offer valuable advice.

When I went to Perthshire fourteen years ago I discovered that many of the failures of basic slag dressings were due to the fact that insufficient amounts were being applied. I was able to demonstrate that the text-book dressing of slag of 10 cwt. per acre was a pure waste of money, while striking results could be obtained by applying twice this amount. I concluded then that a great deal of our Scottish soil is so completely devoid of phosphates that the first 10 to 15 cwt. is used up by the soil itself without leaving any residue as plant food. I find the colour of the soil and the drainage water a good guide as to the phosphate requirements of any field. The results even of my best trials with basic slag used as a top-dressing on old pastures never satisfied me. The results were wonderful I admit, but I could never get grass when I wanted it most, namely, during March and April.

My aim in recent years then has been to get early grass, and this means getting rid of bent grass altogether. I have attempted to get rid of bent grass by harrowing, by burning land with chemicals, by grazing management as advocated by Martin Jones, and none of them has been very successful. The best of my trials in ridding the land of bent was obtained by poisoning the land with a heavy dose of calcium cyanamide, but I regret that I did not follow up this line further.

After dressings of basic slag and potassic mineral phosphate, the next stage in grassland improvement fashion was grassland harrowing. I gave this fashion a fair trial, using grassland harrows imported from Sweden at no little cost. These harrows were said to be better than any British make, but I don't think so. They succeeded in making the bent grass on a plot in Fife grow more luxuriantly than ever. It actually took twice as long to harrow this plot as it took to plough out an equal area in the same field and the quantity of paraffin used was more than double.

The problem I wanted to solve was how to get rid of bent grass altogether and put in its place really good and early grasses, and I wondered why we should try everything except the plough.

Several years ago, therefore, I planned to tackle the question of getting rid of bent by ploughing. I had profited by my observations on harrowed land and decided that either the bent would have to be buried deeply or I should have to take a chance of burying it relatively shallow and hope that the sown grasses would win the race for ground space.

One of the problems which I had previously tackled was getting grass to grow on soft land on farms in Fife. Fife farmers are good husbandmen and believe in sinking the plough, but this very sinking of the plough was all against a good take of grass seeds. Indeed the only good takes on many fields were where the land was consolidated by the wheels of carts, the horses' hoofs, etc. I was therefore all against deep ploughing. I planned then to plough with a wide furrow, as wide as possible, and to invert the furrow completely so that the seams through which the bent might grow would be far apart. At the same time I decided to plough as shallow as would just skim off the turf with an inch or so of soil on top. My reason for doing this was to leave the land after ploughing in a state which would permit of thorough consolidation

In my original experiments I forbade the use of any harrows except a set of very light grass seed harrows. The land was rolled three times after ploughing, and before seeds were sown, and once again after the seeds had been harrowed in. I was pleased when I found that my planning was turning out to my expectations.

I have since then conducted many grassland improvement schemes on similar lines covering some hundreds of acres. I am not now so much afraid of harrows as I was at first. In fact, I now advocate going over the land once with disk harrows, but *only in the direction of the ploughing.*

I consider thorough consolidation after ploughing one of the major operations, and on occasion I have insisted on the land being rolled no less than eight times before I considered it in a fit state to receive grass seeds. If I could borrow a road-roller to consolidate the land before re-seeding I would do it.

I have recently had an opportunity of testing a new method of consolidating land, not for grass seeds but for fine garden seeds.

I ploughed the land thoroughly with a two-furrow Ransomes Junotrack plough. This I regard as the best plough on the market, but it requires a track-laying tractor to draw it. Ploughing was done to 12″ deep by 18″ wide. I decided to roll a small area with the tracks of the tractor. This was so successful that I went on to have nearly 2 acres of garden ground rolled in the same way in less than an hour, at a charge of 8s. per hour. This is much cheaper than rolling with a flat roller anything from four to eight times.

I feel now that the cultivation methods adopted in Fife have justified themselves in practice, and that the time has come for the introduction of a specially built two-furrow tractor plough with heavy narrow furrow compressors attached to reduce the cultivation costs.

I am hoping that when the war is over British implement makers may produce a plough with roller attachments to make grassland rejuvenation really worth while. It is not possible to indicate here how firm the land should be to hold grass seeds. If I could take you down to some of the places where I have been working I could demonstrate there that any bare patches are to be found on improperly packed areas. Mr Jones, who visited a few fields that have been re-seeded under my general supervision, can vouch that the only bare spots he found were on areas which "sprang" underneath him when he trod on them firmly. He can also testify that I have tackled some really difficult ploughing problems with a high degree of success. He asked me why I had deliberately chosen so many difficult places to plough, and my reply was that I saw the need of good pasture on land difficult to cultivate to make up for the good pastures grown on arable land which would have to be ploughed out to grow crops.

War-time conditions demand that good pastures be made on areas that are rough and difficult to cultivate, so that a proper balance between live stock and cropping may continue.

It may be possible to farm without farmyard manure at Rothamsted, but our Fife lands need the dung to conserve moisture if for nothing else.

I should like here to say a word about grass seeds. I much prefer Italian rye-grass as a nurse crop to any other. Rape, if it grows well, tends to retard the sown seeds and to give the bent grass at the seams a chance to reappear and win the race against the good grasses.

I also prefer commercial strains of grasses to the new strains. These may be more persistent, but they are too slow in establishing themselves, and much too slow to grow in spring. I insist that early grass is the only grass that pays for the work involved.

The only indigenous grass I favour is wild white clover, which is, of course, not a grass at all. There are places where I would recommend indigenous strains of grass being included in the mixture, and that is where ploughing presents difficult problems. In these special cases too I would recommend special grazing management.

Now for management. During recent years we have heard a great deal about the correct management of our pastures. We must rest them in autumn to get cocksfoot and again in spring to get perennial rye-grass. I know that the benefits of this

management can be demonstrated, but as long as the early bite and autumn grass pay the farmer why should he shut his stock off in order that he may have a pretty pasture to look at during May, June and July, when any fool can grow grass at that season?

My advice would be to use the precious grass at the most profitable season. When it ceases to be early enough and bent comes in, it is time to renew it again by ploughing.

Just one word about manuring before I close. I consider that grassland that is failing is growing on land which is deficient in readily available nitrogen. In addition to applying a really good dressing of phosphates (and here I mean a dressing of phosphates —not a lick of ten cwt. per acre and a promise which is never kept), I would recommend a top-dressing of 1 cwt. sulphate of ammonia or its equivalent. This, in addition to permitting every seedling plant to grow, helps them to grow quickly and fill the ground before my enemy the bent grass can recover from the shock of being buried alive.

THE CHEMICAL ASPECT OF GRASSLAND IMPROVEMENT.

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Soil Conditions of Old Grassland.—For some years the Edinburgh and East of Scotland College of Agriculture has undertaken a considerable amount of research and advisory work on the question of grassland improvement and in particular on very poor old grassland. In this connection laboratory analyses have been carried out on a large number of soil samples drawn from numerous experimental areas and more recently from farms where information was required about soil conditions on old grassland ploughed up under the subsidy scheme. For convenience, these have been called "Old Grassland Soils."

A brief survey of the analytical results gives a very good picture of the main soil deficiencies on this type of land and for comparison figures obtained in the College laboratory and tabulated in a recent number of this *Journal* have been used.[1] During the last four or five years more than 8,000 samples of soil have been examined for purely advisory purposes. Most of these samples were taken by the County Organisers and represent all the soil types and farming conditions met with in the East of Scotland area. These can be called "Normal Farm Soils," in contradistinction to those mentioned above.

Normally, every soil sample is tested (1) for "degree of acidity," that is *p*H, (2) for "lime requirement"—stated here as the amount of lime required to reduce the acidity to a *p*H 6·5, (3) for "available phosphorus," by means of an extraction with dilute hydrochloric acid, (4) for "available potassium," where the growth of the fungus *Aspergillus niger* is taken as a measure of available nutrient. Long experience of the last two methods, i.e., the estimating of available phosphorus and potassium, has made it possible to say whether a soil is "low," "medium" or "high" in available nutrients.

A comparison of the two groups of soils is given in the following tables:—

OLD GRASSLAND SOILS.

Range of pH Values.

Below 5·5 per cent.	5·5–6·0. per cent.	6·0–6·5 per cent.	*Over* 6·5 per cent.
14	52	18	16

[1] *Scot. Jour. Agric.* 1939, XXII., 353.

Lime Requirement cwt./acre CaO *to* pH 6·5.

	per cent.	per cent.	per cent.	per cent.
Over 30 cwt. -	13	29	1	......
0 to 30 cwt. -	1	23	17	......
Nil - -	......	......	......	16

Available Nutrients.

	Phosphorus.	*Potassium.*
	per cent.	per cent.
Low - -	62	25
Medium - -	33	38
High - -	5	37

NORMAL FARM SOILS.

Range of pH *Values.*

Below 5·5	5·5–6·5	*Over* 6·5
per cent.	per cent.	per cent.
19	55	26

Lime Requirement cwt./acre CaO *to* pH 6·5.

	per cent.	per cent.	per cent.
Over 30 cwt. -	16	15	......
0 to 30 cwt. -	3	40	......
Nil - -	......	......	26

Available Nutrients.

	Phosphorus.	*Potassium.*
	per cent.	per cent.
Low - -	23	34
Medium - -	45	43
High - -	32	23

The results are expressed as percentages of the total number of samples analysed, and in the case of the "Old Grassland Soils" about 500 samples have been considered.

Taking each analysis in turn, certain well-defined points can be picked out.

Lime Status.—On the whole, the lime status of most of the soils is not too serious, for it is doubtful whether it is necessary to lime those soils with a pH over 6, i.e. 34 per cent. of the soils under consideration.

Many soils in the next group, pH 5·5–6·0, appear to do fairly well without lime when ploughed and re-seeded to grass. So long as *other soil deficiencies* are made good, satisfactory establishment of seeds can be obtained. The effect of liming on the more acid of the soils in this group can be seen, however, after a few years, when the unlimed plots begin to go back.

On soils with a pH below 5·5, a group into which 14 per cent. of the soils fall, some interesting results have been obtained. Two

experimental areas, one at Kirknewton and the other at Mid-Calder, on which ploughing, slagging and re-seeding were carried out, have shown a surprisingly small effect from liming, even although the pH values were about 5 and lime requirements high according to ordinary standards. At one centre figures for the live-weight increase of sheep are available in addition to yield figures for smaller plots, and differences due to liming are not spectacular. It must be emphasised, however, that these statements refer only to the first year, and it is fully anticipated that differences will become apparent in the course of time, as was the case in other experiments.

At the College farm at Boghall, on the other hand, where the soil pH was 4 and the lime requirement very high, little or no result could be obtained until lime was applied, even although large dressings of phosphatic manures were given. In so far as yield figures are an indication of improvement, it can be said that plots receiving lime produced up to three times as much as the unlimed controls.

Experiments with incremental dressings of lime are at present being undertaken, and whilst it is too early to give a statement of results, it may be said that the indications are that light to moderate dressings are best and heavy dressings are harmful.

It is difficult to generalise in regard to liming, but it can be taken that satisfactory dressings are of the nature of one ton per acre high-grade ground lime.

It may be useful to give at this point a word of explanation of the methods used in the experimental areas under consideration. The land is ploughed, the furrow being completely inverted, after which the lime and manures are disked into the back of the upturned furrow. This is followed by seeding and rolling. The production of a satisfactory seed-bed in a rather shallow surface layer is the aim of this method, and may explain why relatively small applications (small when compared with the interpretation of the lime requirement figures on arable soils) are so effective.

Available Phosphorus.—Nearly 62 per cent. of the soils considered are deficient in available phosphorus as compared with 23 per cent. in the "Normal Farm Soils." Continued grazing over long periods without the addition of phosphatic fertiliser has resulted in what amounts to almost complete removal of available phosphorus from the soil. There is no doubt that in ploughing and re-seeding of pasture the addition of phosphorus is of the utmost importance. In some of the acid soils mentioned above good establishment was obtained with basic slag alone; without slag there was complete failure. Even relatively small dressings of slag produce remarkable results. On a number of experimental areas, where dressings of 5 cwt. per acre and 10 cwt. per acre basic slag have been compared, there has been relatively little

difference in establishment and yield in the first year. All of these plots received applications of lime, but lime alone without slag was a complete failure.

The form in which the phosphorus should be added is a point much discussed. Some farmers prefer basic slag and some ground mineral phosphate, but there are indications that the higher solubility of the phosphorus in basic slag is beneficial in establishing young seeds.

Available Potassium.—When compared with normal soils, the "Grassland Soils" have far fewer in the "low" group (25 per cent. as against 34 per cent.) and many more in the "high" group (37 per cent. as against 23 per cent.).

Sectioning of the soil shows that much of the potassium is near the surface, and in many cases there is more than twice as much in 0-3" layer as in 3-6" layer. It can be argued, therefore, that shallow ploughing should be carried out to retain the potassium. After ploughing, the potassium content of the surface soil shows a decrease, which is due to turning up the poorer subsurface soil.

A number of the soils in the group low in potassium were found to come from policy parks which had seldom been grazed and had, in some cases, been cut for hay or bedding. In the other soils it is fairly obvious that much of the potassium had been returned to the soil in excreta from animals which had perhaps received additional feeding containing potassium.

In most cases good establishment of seeds was obtained without the addition of potassic manures, but how long the natural supply will last is not yet clear. In some of the poorer soils a response to potassium was observed in the second year. It is possible from a study of the soil analysis, however, to be reasonably certain whether or not potassic fertilisers are required.

Available Nitrogen.—No mention has been made of the nitrogen content of the soil. Generally, it is assumed that decomposition of the turf, assisted by liming and manuring, produces a supply of available nitrogen, but in the early stages this reaction is slow, and it has been found beneficial to add up to one cwt. per acre nitro-chalk to the young seeds.

Conclusions.—A study of the soil analytical data makes it clear that long-continued grazing removes much of the calcium and nearly all the phosphorus from the soil, whilst the potassium is largely retained.

In addition, of course, calcium is not strongly held in the soil complex and is readily exchanged and removed by leaching. This results in increased acidity, followed by the appearance of soluble iron and aluminium which in turn combine with more phosphorus and render it unavailable.

The first step, then, is to make good the calcium and phosphorus deficiencies by liming and slagging. On the majority of fields this has meant the application of about one ton per acre ground lime and up to 10 cwt. per acre basic slag. In many cases this is all that is required in the first year, unless it is decided to give nitro-chalk. Potassic fertilisers may be required in the second year, and the dressing should be arrived at after consideration of analytical figures.

Ploughing should be relatively shallow to conserve the nutrients already in the vegetation layer, i.e., potassium and nitrogen, and cultivation and manuring should be confined to a shallow surface layer to enable the fertility to be built up with a minimum of lime and manures.

It is undoubtedly the case that soil analyses are of great value in assessing the lime and manurial requirements of this class of land, and soil-testing facilities should be made use of whenever possible.

SEED MIXTURES FOR RE-SEEDING.

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ONE point which I think this conference has made amply clear is that in the improvement of our poor "marginal" grasslands the plough is going to be one of the most potent factors, and I believe that if a farmer goes to the trouble and expense of ploughing he almost certainly will give careful thought to his choice of a seeds mixture.

The present arable campaign initiated by the exceptional demands of war-time has indirectly focussed attention on the problem of raising the yields of pastures now lying in a semi-derelict condition. Renovation of such pastures is a matter of urgency in view of the inevitable pasture shortage resulting from this increase in our arable acreage at the expense of the more favourably situated grassland. In order to make good this deficiency it is obvious that we must aim at increasing the productivity of the remaining pastures without seriously interrupting the grazing continuity. In planning to do this we must bear in mind the needs of the times and decide whether it is in the country's interest to obtain the highest possible pasture production for say the next three or four years, or whether we should attempt to spread the improvement over a longer period by re-sowing to "permanent" grass and be content with somewhat lower initial yields. Personally, I feel that we ought to adopt a system of short-duration grass and make every endeavour to obtain high production in the shortest possible time for two main reasons: (1) maximum pasture yields are needed immediately, and (2) some of the renovated areas are likely to be required shortly to augment our present arable acreage, and with this probability in view the sowing of relatively costly permanent seeds mixtures would not be justified.

Now, of the available pasture grass species those of the greatest potential productivity are Italian rye-grass, perennial rye-grass, cocksfoot and timothy. But since it is our intention to avoid losing grazing during the process of re-grassing we must consider using in addition ultra-quick-growing plants capable of supplying the grazing animal with food while the pasture species proper are establishing themselves.

After what Captain M'Dougal has said, I may seem to be rather optimistic in including perennial rye-grass in my list. The bad reputation of Ayrshire perennial in upland districts is, I think, to some extent due to the wrong application of lowland methods to upland conditions. For instance, at the Society's upland Sub-

Station, the sowing of rye-grass under the customary grain crop of oats has given very unsatisfactory results. When, however, Ayrshire perennial was sown in another part of the same field under a *grazing* nurse crop of oats and given a grazing treatment which favoured wild white clover, the result was eminently satisfactory. These examples illustrate how responsive rye-grass is to the treatment it receives. To bring out its pasture attributes, e.g., length of life, palatability, etc., every effort should be made to provide it with a suitable environment; on poor land in particular an abundance of wild white clover is an essential part of this environment.

I have said nothing about bottom-grasses. If our object is to obtain the highest possible yields, why include the relatively low-yielding bottom-grasses when the requisite pasture density can equally well be achieved by encouraging the spread of the much more valuable wild white clover? In fact, on poor soils the clover, while indirectly raising the yields of the most productive grasses, itself contributes largely to the supply of animal food.

Everyone knows that in lowland pastures mixtures of Italian rye-grass, perennial rye-grass, cocksfoot and timothy give good results. In semi-derelict areas of the kind we are discussing, however, it is proposed to sow the seeds, not with a grain nurse crop as in the lowlands, but with a grazing nurse crop, an environment which accelerates turf-formation and thus favours the establishment of the rapid growing and most vigorous seedlings. Consequently, the weak seedlings of timothy find themselves competing with the more vigorous cocksfoot seedlings, which in turn are competing with the still more vigorous seedlings of rye-grass under conditions that become progressively more unfavourable to the growth of the weak seedlings.

The question therefore arises, is it really sound practice to sow mixtures of these species under the conditions accompanying a grazing nurse crop?

At the Society's upland Sub-Station we have been studying the behaviour under grazing nurse crops of species mixtures *versus* varietal mixtures. The trials were conducted at an elevation of 900 feet on a moist mineral soil previously very deficient in plant food material. Before ploughing, the vegetation consisted of a mat composed mainly of *Agrostis* and sweet vernal grass. In one series of plots a mixture of 16 lb. per acre of Ayrshire perennial, 18 lb. of Danish cocksfoot, and 6 lb. of Stirlingshire timothy was sown with wild white clover and a grazing nurse crop of oats. On the basis of the viable seeds sown the grass proportions in the resulting pasture should theoretically have been 20 per cent. rye-grass, 46 per cent. cocksfoot and 34 per cent. timothy, instead

of which an analysis 15 months after sowing gave the establishment values 64 per cent. rye-grass, 24 per cent. cocksfoot and 12 per cent. timothy. The aggressiveness of the rye-grass at the expense of both the cocksfoot and timothy is therefore a prominent feature.

Apart altogether from the loss of the relatively costly seeds of cocksfoot and timothy, the yield of fodder in the second year from the mixture plots was less by 8 per cent. than that from a series of plots containing only perennial rye-grass and wild white clover, and also less by 7 per cent. than that from another series containing only cocksfoot and wild white. Moreover, the mixture plots contained 25 per cent. more weeds than the rye-grass plots and 4 per cent. more than the cocksfoot plots, but 17 per cent. less than the plots of timothy.

On the basis of these results it would seem reasonable to conclude that nothing had been gained by the sowing of mixtures of grass species. In fact, the inclusion of the timothy had apparently given the weeds their opportunity.

On the other hand, it is an advantage to make full use of mixtures of varieties of the same species. For instance, the highest seasonal yields of rye-grass were obtained from plots sown with a mixture of Ayrshire perennial and a late-flowering variety. Similarly, the highest cocksfoot yields were obtained from plots sown with a mixture of early and late varieties. Thus under the prevailing conditions the most satisfactory results were obtained when there was the least difference in vigour between the seedlings of the sown grasses.

The aggressiveness of Italian rye-grass is even greater than that of perennial rye-grass and its lavish use cannot be recommended. The addition of small quantities, however, considerably increases the bulk in the seeding year and the early part of the succeeding year; it does not tend to subsequent depreciation of the pasture, provided it is grazed early as would be done if oats were used as the grazing nurse crop. We found that to use Italian rye-grass as the sole nurse crop adversely affected the establishment and subsequent spread of wild white clover to the detriment of the growth and palatability of the associated grasses.

The time at which the nurse crop is first grazed is very important. For example, three series of plots, sown on the same date, 20th May, were grazed for the first time on 13th July, 25th July and 9th August respectively: these gave grass-clover ratios in the second year of 100: 107, 100: 78 and 100: 20. Postponement of grazing thus progressively diminished the representation of wild white while at the same time it had no adverse effect on the grasses.

The following seeds mixtures (in rates per acre) are suggested for re-grassing directly to pasture:—

(1) *For moist soils:*—

(*a*) Where early grazing is required in the seeding year—

2 bush. Sandy Oat
2 bush. Grey Winter Oat } or 4 bush. Sandy Oat.
20 lb. Ayrshire Perennial Rye-grass.
20 lb. Late-flowering Perennial Rye-grass.
1 lb. Wild White Clover.

Or,

2 bush. Sandy Oat
2 bush. Grey Winter Oat } or 4 bush. Sandy Oat.
5 lb. Italian Rye-grass.
10 lb. Ayrshire Perennial Rye-grass.
20 lb. Late-flowering Perennial Rye-grass.
1 lb. Wild White Clover.

(*b*) Where early grazing is not essential and when bulk is required later in the seeding year—

4 lb. Rape.
5 lb. Italian Rye-grass.
10 lb. Ayrshire Perennial Rye-grass.
20 lb. Late-flowering Perennial Rye-grass.
1 lb. Wild White Clover.

In the case of drier soils it may be an advantage to replace some or all of the perennial rye-grass by cocksfoot, but information on this point is lacking and the following mixtures must therefore be regarded as only suggestions.

(2) *For relatively dry soils:*—

5 lb. Italian Rye-grass.
10 lb. Ayrshire Perennial Rye-grass.
20 lb. Cocksfoot.
1 lb. Wild White Clover.

(3) *For dry soils:*—

5 lb. Italian Rye-grass.
15 lb. Early Cocksfoot.
15 lb. Late-flowering Cocksfoot.
1 lb. Wild White Clover.

Since indigenous grass strains have been mentioned by more than one speaker I should like, just before concluding, to say a few words regarding them. In the first place the use of the word indigenous, as it is now commonly applied, while not wrong, is somewhat misleading. For instance, the species *Lolium perenne* is indigenous to this country and, since the probability is that our home-grown commercial perennial rye-grass was originally

derived from native stock, home-produced commercial perennial rye-grass is just as much indigenous as the recent productions from our plant breeding stations.

As long ago as the very beginning of last century the commercial value of perennial rye-grass collected from old pastures or mountain ground was appreciated. History is therefore repeating itself in so far as old pastures are once again being explored for rye-grass. Much of the rye-grass collected from such situations is late-flowering and slow to develop in the spring. These late types do not necessarily represent ready-made races of agricultural value, but they do provide material for the breeding of useful late-flowering varieties. Since in commerce early-flowering varieties are common and late varieties rare the breeder has naturally concentrated his efforts on the latter.

The very fact that the majority of the new varieties now under trial or already on the market are late-flowering has led to some misconceptions as to their place in grassland economy. The purpose of the late-flowering variety is primarily to level out the peaks and declines in production exhibited by early varieties during the growing season and to extend the grazing season at the end of the year. Incidentally the palatability of the fresh new growth of late varieties, coming as it does at a time when the early varieties are becoming less palatable, encourages even grazing. We heard only yesterday that a pasture sown with indigenous strains was not a success because the grasses took so long to grow in the spring. This experience will almost inevitably be of frequent occurrence until it is realised that late-flowering bred strains are not intended to replace the early commercial varieties but to be their complements.

THE RECLAMATION OF PEAT LAND IN LANARKSHIRE.

The Carnwath Experiment.

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THE large area of moorland in Scotland makes the question of improving such land a matter of considerable importance. Peat land can be divided into two main classes, fen and moorland. Fen develops where drainage water rich in plant nutrients collects in hollows and supports such plants as reeds and sedges. When it has been suitably drained peat of this type makes good agricultural land. It has been reclaimed successfully in East Anglia, and to a lesser extent in certain other parts of Britain. Moorland or moss is associated with rain-water or ground water very poor in bases and the vegetation is composed mainly of certain mosses, coarse grasses such as Cotton grass (*Eriophorum*), Deer grass (*Scirpus*) and Mat-grass (*Nardus*) and heather, heath, etc. The peat formed under these conditions from these plants is usually very acid in reaction and poor in plant nutrients. Most of the peat land in Scotland belongs to this class, although the bottom layers of some of the basin types are of the fen class. The bulk of the Scottish moorland is used for sporting purposes and it also provides a certain amount of rough grazing for sheep. In many districts where the peat covering is thin it has been reclaimed for arable land, the surface peat being incorporated with the underlying mineral soil. Very little deep peat of the moorland class has been reclaimed, but in regions such as the Island of Lewis where there is a shortage of mineral soil some deep peat has been brought under cultivation by the lazy-bed system.

Considerable areas have also been reclaimed after removal of the peat for fuel, and in the Moss of Blairdrummond Lord Kames reclaimed land after stripping off the peat and floating it down the river Forth. The modern method of peat reclamation, however, is to drain the moss and cultivate the surface, and two experiments by this method have been carried out by the Macaulay Institute. The first was done in the Island of Lewis on slimy, highly-colloidal peat of the *Scirpus* type; descriptions of the work have appeared in this *Journal*.[1] The second was carried out near Carnwath in Lanarkshire on another of the main types of moorland peat found extensively in the east and south of Scotland, a fibrous type derived mainly from Cotton grass with heather and Sphagnum moss.

Scope of the Experiment.—In exploring the possibilities of the

undeveloped resources of the areas in the south of Scotland where unemployment was most acute, the late Sir Arthur Rose, Commissioner for the Special Areas in Scotland, decided to carry out an experiment on the reclamation of moorland, which in this region is very extensive and poorly utilised. The undertaking was entrusted to the Macaulay Institute for Soil Research, and its purpose was to provide information as to the cost of reclamation by modern methods and the value of such land after it was reclaimed. The type of peat and the general conditions are very different from those prevailing in the Island of Lewis where moorland reclamation had already been done.

Woodend Farm, near Carnwath, in Lanarkshire, was acquired by the Commissioner and two peat mosses, Woodend and Blackgate, which form part of this farm and comprise an area of over 500 acres, were used for the experiment. The altitude is 700 ft. above sea-level and the average annual rainfall 35-40 in. Both rainfall and relative humidity are considerably lower than in Lewis. The peat mosses were very soft and wet, and their only use was to provide a small amount of inferior grazing for sheep for a short time in summer. Their agricultural value was negligible. The area is shown in the accompanying map.*

Reclamation was commenced in 1936 and completed in 1939.

Character of the Peat.—The peat, which varies in depth from about 15 to 25 ft., occurs in a marshy valley and occupies hollows in morainic deposits. A small stream, the Dippool Water, adjoins the mosses and has been used as the main drainage channel in the reclamation work. The fall from Woodend Moss to the Dippool is sufficient to ensure satisfactory drainage, but in some parts of Blackgate Moss the slope is so slight that drainage has presented some difficulty.

The peat is of a type quite different from that on the Macaulay Farm in Lewis. Like the Lewis peat, it belongs to the moorland or moss group and is very acid, wet and deficient in plant food, but its texture is very different. There is a surface layer of light, partially decomposed moss peat overlying well-decomposed dark brown material and there are tree remains in the lower layers.

The Lewis peat when wet can be squeezed through the fingers like mud, but the surface layers at Carnwath are fibrous and spongy; the plant remains are easily recognisable and seem comparatively fresh; and when the peat is squeezed in a wet condition water flows out as from a sponge and the fibres are not destroyed. On drying, Lewis peat shrinks and cracks, but the Carnwath type remains more or less open in texture. This has, of course, an important bearing on drainage, which has proved to be much easier at Carnwath.

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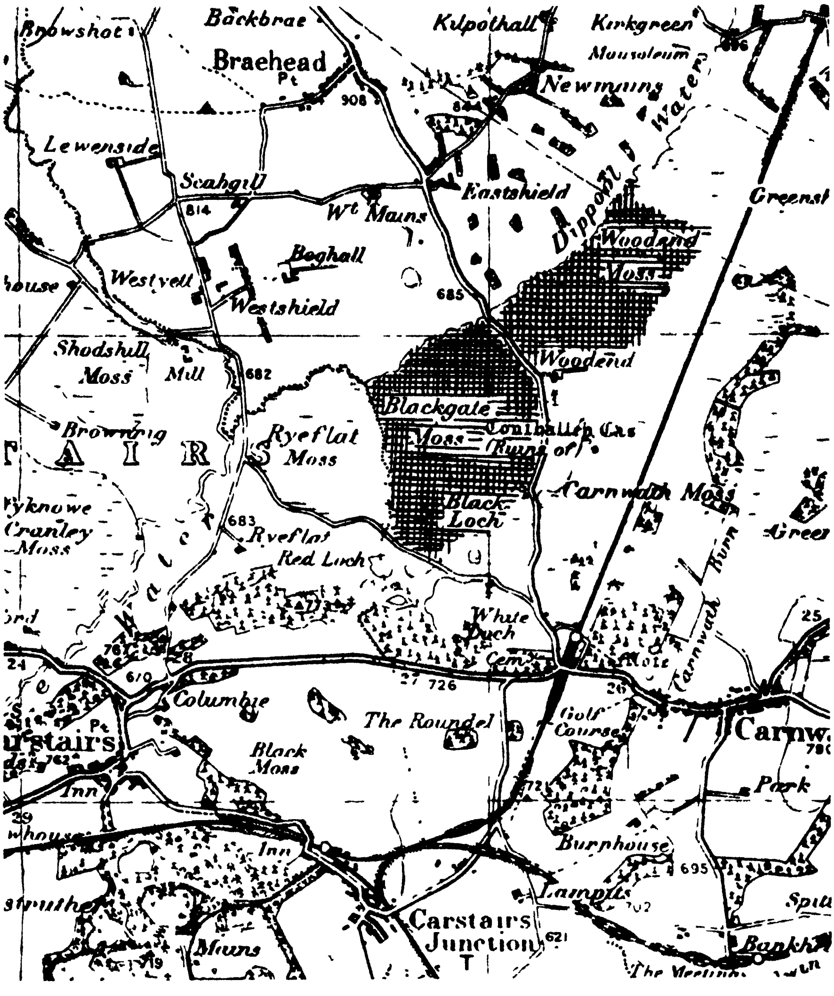

The surface vegetation at Carnwath consists mainly of heather (*Calluna vulgaris*), Cotton grass (*Eriophorum vaginatum*) and species of Sphagnum and other mosses. Chemical analysis showed that the contents of lime, phosphate and potash were very low.

Draining.—The drainage system consists of open collecting ditches which discharge into the Dippool, and covered subsidiaries. The collecting ditches are 200-300 yards apart and 5-6 ft. deep, with sloping sides. They were dug mostly by hand, but an improvised excavator consisting of a large scoop and a small single-cylinder engine proved very useful in dealing with soft wet peat and in deepening ditches. The subsidiary ditches were cut to a depth of 20-24 in. by means of a large draining-plough reconstructed for the purpose, and then deepened to 4 ft. by hand. The

draining-plough was drawn by a 30 h.p. Fowler crawler tractor. The use of the draining-plough halved the cost of the excavation of the subsidiary ditches compared with hand digging alone. The subsidiaries discharge at intervals of 20 yards into the collecting ditches.

After excavation the subsidiaries were left open for at least a year to allow for shrinkage of the peat, after which wooden-box drains were laid and the ditches filled in. The box-drains consisted of planks ½ in. thick and 4 in. wide nailed together to form a continuous box throughout the whole length of the drain. The top was raised slightly on small wooden strips to allow the drainage water to enter.

The subsidiary drains were not cut directly into the collecting ditches, but stopped a few feet away, leaving the sides of the latter unbroken. A hole was then cut through at the level of the sole of the subsidiary drain and the wooden-box drain pushed into this. The minimum fall required for drainage is 0·25 per cent. The extent of the draining operations may be judged from the fact that over 8 miles of collecting ditches and nearly 50 miles of subsidiary drains have been made. A more detailed description of this type of drainage system has been given in this *Journal.*[2]

Liming.—Chemical tests showed that lime was required at the rate of about 2 tons CaO per acre. A supply of paper-works waste lime was available about 25 miles away, and part of the area was treated with this at the rate of 5-6 tons per acre. It was applied from a sledge drawn by the tractor. The remainder of the area was treated with ground lime.

Manuring.—Most of the area was manured at the rate of 9 cwt. per acre high-grade, high-soluble basic slag or its equivalent as ground mineral phosphate and 4 cwt. per acre 30 per cent. potash manure salts. These were found to be satisfactory initial dressings. Nitro-chalk was applied at the rate of 1-1½ cwt. per acre. Farmyard manure produced excellent results, but was available only for a small experimental plot.

Cultivation.—Before cultivation the surface vegetation was removed by burning and the lime applied. Cultivation was done by means of a Fishleigh rotary cultivator drawn by the crawler tractor. After the first cultivation the manures were applied and cross cultivation done to a depth of 4-6 in. The surface was uneven originally and heavy harrows were used to level it and prepare a seed-bed.

After seeding, the seeds were covered by means of light harrows, and the land was rolled by a large water-filled roller weighing 3 tons.

Two hundred and fifty acres were fully reclaimed in this way and the open collecting ditches fenced off. A further area of about

two hundred acres was partially improved as grazing land. The open collecting ditches were made as before, but the subsidiaries were not excavated to their full depth. The land was limed, cultivated and sown out with a cheap grass-seed mixture.

Cropping.—Reclamation of the first portion of the fully-reclaimed area was completed in the autumn of 1937, and it was sown with grass-seed mixtures without nurse crops in September. The following mixtures were used:—

20 lb.	Perennial Rye-grass (Ayrshire).	7 lb.	Perennial Rye-grass (Ayrshire).
8 „	Cocksfoot (Danish).	20 „	Timothy (Scots).
4 „	Timothy (Scots).	1 „	Rough-stalked Meadow Grass.
½ „	Rough-stalked Meadow Grass.	1½ „	Late-flowering Red Clover.
1 „	Crested Dogstail.	2 „	Alsike.
1½ „	Late-flowering Red Clover.	1 „	Wild White Clover (Kent).
2 „	Alsike.		
1 „	Wild White Clover (Kent).		
38 lb.		32½ lb.	

In spite of the lateness of sowing an excellent braird was was obtained and both grasses and clovers came through the winter well. Part of this area was cut for hay and gave a yield of about one ton per acre; the remainder was grazed. Both mixtures were satisfactory and it is still too early to decide which is the more suitable for these conditions. Timothy and rye-grass have both done well and a field of Italian rye-grass yielded two tons in two cuts in its second year. Clovers have presented no difficulty and in all the fields an excellent growth of wild white clover has been obtained. By the end of 1939 nearly 250 acres of the fully-reclaimed area and 200 acres of the partially reclaimed area had been sown out in pasture, and in the portion cut for hay in 1939 the average yield was nearly 1½ tons per acre with a maximum of over 2 tons in some areas.

Small areas of silage crops consisting of oats, beans, peas and tares were grown in 1938 and 1939, and yields of 10 tons per acre obtained. Oats were also grown, but ripened slowly and tended to lodge. Small areas of potatoes were grown successfully, but in the friable newly cultivated peat land there was some difficulty in drilling potatoes. Turnips, rape and marrow-stem kale were not a success, but further tests will be carried out when the land has been longer under cultivation.

Legumes were found to grow much better if they were inoculated before sowing.

Experiments.—Various experiments have been carried out during the progress of the scheme and experimental work will be continued. The main results already obtained are:—

1. It is immaterial from the point of view of crops whether paper-works waste lime or ground lime is used, provided

equal amounts of CaO are applied. In this case the waste lime was cheaper.

2. Basic slag has up to the present given better results than ground phosphate. Plots treated with slag yielded almost three times as much hay as those receiving the same amount of P_2O_5 in the form of ground mineral phosphate.
3. Legume seeds inoculated before sowing did much better in the first year than uninoculated seeds.
4. Newly reclaimed peat land is very deficient in available nitrogen and dressings of nitro-chalk or nitrate of soda are essential.
5. The application of farmyard manure in quite small amounts gives a response out of all proportion to the manurial constituents applied.
6. Heavy and frequent rolling is essential, especially after the "heaving" caused by frost.
7. Overdraining is harmful, especially to clovers.

Cost.—The cost naturally varied somewhat over the area, depending on the surface conditions and drainage difficulties. Surface levelling by hand was necessary here and there, while in very wet spots there was difficulty in forming the ditches and these had to be cleaned up and re-deepened a few times. The average cost per acre may be taken as follows:—

Cutting main ditches - - -	£2	0	0
Cutting subsidiary ditches - -	4	0	0
Making and laying wooden-box drains (including timber) - - -	7	0	0
Liming and manuring - - -	6	5	0
Cultivation, harrowing and rolling -	1	5	0
Seeding - - - - -	1	10	0
	£22	0	0

As this includes liming, manuring and seeding, normal farming operations, which should not properly be charged against reclamation, a deduction of about £7 could probably be made, bringing out the cost of reclamation at £15 per acre..

In this experiment all the workers except the foreman were previously unemployed. In reclamation work undertaken by the State for the relief of unemployment allowance would require to be made for this, as labour constitutes the main part of the cost. It could probably be safely estimated that the actual cost to the State did not exceed £7 10s. per acre.

The area partially reclaimed for grazing has not yet been costed in detail, but as wooden-box drains were not laid, and liming,

manuring and seeding were done on a cheaper scale, the cost will be much less.

Conclusions.—The experiment at Carnwath has provided information as to the cost of reclamation of peat land of one of the most widespread types in Scotland. The land is now being farmed under the supervision of the Department of Agriculture for Scotland and the agricultural value of the reclaimed land will be established.

The experiment has supplemented the information already obtained in Lewis on peat land reclamation and has shown that the type of peat found at Carnwath can be successfully reclaimed and made to produce good crops. It is more easily drained and more suitable for agriculture than the type which occurs in Lewis.

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2. Robertson, I. M., *Scot. J. Agric.*, 1933, **16**, 160.

DRY ROT DISEASES OF POTATOES.

C. E. FOISTER

THE importance of supplying sound, rot-free potato tubers, whether for seed or for ware, is too obvious to require to be stressed; growers and dealers alike realise it.

By far the most serious disease causing deterioration of stocks of stored potatoes and consequent losses to farmers and merchants is Blight (*Phytophthora infestans*) which, by itself, causes a solid chocolate-coloured decay of the tuber. Commonly blighted tubers are subsequently attacked by other putrefactive organisms which reduce affected tubers to a mass of wet, evil-smelling pulp. Sometimes, however, the rotting area in a Blight-affected tuber dries up and in some respects simulates a dry-rot condition. But, quite independently of Blight, there is a group of diseases of stored potatoes collectively describable as dry rots, which cause considerable annual losses and of which the symptoms and control measures are rather similar, although the dry-rot condition is not always attributable to attack by the same organism. The incidence of the trouble varies from season to season and losses commonly range from 5 to as high as 75 per cent. The potato trade has become fully alive to the importance of controlling this disease condition, and the following description is given to enable those interested to recognise it in its earlier stages and to take such measures to obviate deterioration as are possible in the light of our present knowledge.

Distribution.—Dry Rot, caused by *Fusarium caeruleum,* is known to be widely distributed in the British Isles and is recorded also from Europe, North America, South Africa and India. Gangrene, caused by a species of *Phoma,* is at present known only in various parts of the British Isles (Eire, N. Ireland, England, Wales and Scotland).

Description.—Dry Rot commences as a small sunken area, which is soft to the touch and usually of a darker colour than the unaffected part of the tuber. As this area increases in size the skin becomes wrinkled in irregular concentric rings; pustules or cushions of the fungus burst through the skin and the affected tissues shrink (Fig. 1). The fungus cushions are white to pinkish, and, when broken away from the skin, may show a bluish base. The rot may develop anywhere on the tuber. When the rotted tuber is cut, the disease is seen as a brown, mealy rot in which cavities develop, often lined with a light-coloured fluffy growth formed by the organism, within which blue portions are commonly seen. There is no well-defined margin to the rot, and this helps to differentiate it from Gangrene. Eventually, affected tubers become mummified, hard, dry and very light in weight.

Gangrene commences as a small depression, not unlike that found with Dry Rot. In this instance, however, the tissues remain reasonably firm. The depression increases in area slowly and may develop in one of two ways. The rot may stop when it is about $\frac{1}{2}''$ to $1\frac{1}{2}''$ diameter and tend to dry up (Fig. 2); it then forms a depression or "thumb-mark," which may be removed by the finger-nail quite neatly, leaving a clean hollow. In this type the rot is shallow internally and may do little harm. A thin reddish-coloured fluid can be expressed from these depressions at the stage where the diseased area has not yet dried up. This fluid sometimes exudes and is probably infective. Alternatively, the rot may develop both in surface area and internally until most of the tuber is involved. Commonly, in this type of rot, the tuber collapses and forms a shrunken wrinkled mass as in Dry Rot. Inside the tuber, small or large cavities develop (Figs. 3 and 5) which are lined with a loose felt, the colour of which ranges from pink to brown. Very rarely a third symptom appears, viz., very shallow, dry, irregularly spreading, dark-coloured depressions almost resembling those of Blight, but lacking, in the cut tuber, the irregular rusty brown internal marks characteristic of the latter; instead, the rot is superficial and of a dry dark orange colour. No white or pink cushions develop, as in Dry Rot, but minute black bodies, the size of a pin's head, may burst through the skin in small scattered groups or in long curved lines (Fig. 4). The internal rot is always well delimited by a darker, narrow hard zone.

Infection and Related Factors.—In neither of these two diseases is the growing plant affected. Dry Rot and Gangrene are essentially storage diseases, which reduce the amount of healthy stock suitable for planting. Tubers that become slightly affected with Dry Rot towards the planting period may sprout and, if planted, may, under conditions suitable for the development of the disease, either fail entirely to develop or only produce small (although healthy) plants. Blanks in the crop are often due to the planting of affected tubers. Gangrene-affected tubers will yield a normal crop when planted, unless the greater part of the tuber, including the eyes, is affected with the soft rot stage.

Contamination of the tubers with the fungi that cause Dry Rot and Gangrene occurs while the tubers are still in the soil, but neither disease develops until some time after lifting. It has been proved that the organism causing Dry Rot can live in the soil and infect tubers while these are still in the soil. When the fungus has penetrated into the tissues it is protected against any surface disinfectant that might be applied at the time of lifting. If this were true for all tubers lifted from infected soil, no disinfectant applied afterwards would serve as a measure of control, but fortunately the proportion of tubers that are so

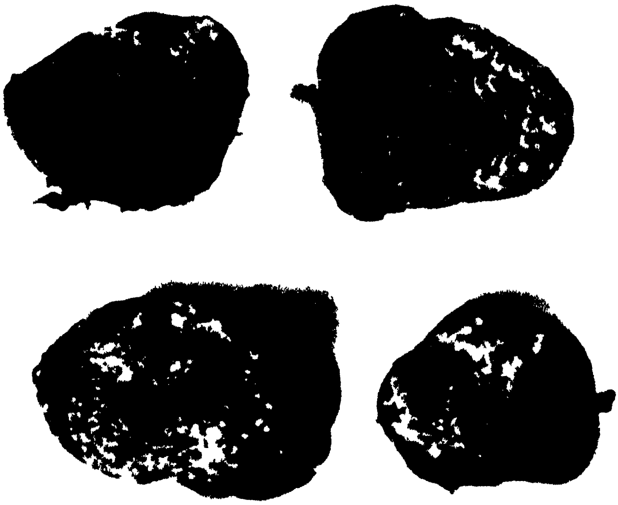


Fig 1

Fig 2

Fig 3

Fig 4

Fig 5

infected in the soil is very small indeed. It is not yet known whether the Gangrene fungus can effect entry into tubers before they are lifted. It is evident that in most cases tubers become infected during the storage period by the disease organisms which may be present in the adhering soil; hence conditions of storage and of the tubers affect largely the subsequent development of the two diseases. Dry Rot usually affects early varieties more than late varieties, and probably for that reason is associated with storage in sprouting boxes rather than in pits. Nevertheless the disease can be severe in the pits, usually in cases where the pits have been opened once or several times for the purpose of dressing and dispatch of stocks. There is little doubt that plenty of oxygen is necessary for the germination of the fungus spores and the reduction of available oxygen in the constantly closed pit is probably an explanation of the absence there of Dry Rot. When, however, the pit is opened in December or later, the spores, if present, are provided with a sudden access of oxygen which enables the fungus to infect the maturing tubers. The same explanation probably applies also to Gangrene. In addition to soil contamination, tubers may become infected by spores developing on other previously infected tubers. These spores are probably carried from tuber to tuber by mites and other insects of pits, potato stores and sheds. Damp air in either store or pit will favour the formation of abundant spores by which other tubers can be infected. It has been proved that the spores causing Dry Rot can exist in a living state on the dry walls and floors of potato stores and that these spores can float through the air and infect stored tubers. Therefore dry conditions alone do not ensure freedom from Dry Rot. Contaminated stores and potato-boxes also serve as common sources of infection. Observations have shown that Gangrene does not spread so readily in boxes as does Dry Rot.

While symptoms of both diseases may appear as early as October, most of the rot develops later in the season, becoming progressively worse as the tubers mature from December and January onwards; early varieties show advanced rot before the later varieties.

Mechanical damage of various types is closely associated with the development of Dry Rot, but much less with that of Gangrene. Although the Dry Rot organism can attack uninjured tubers both in the soil and in storage, any wound or bruise provides an easier mode of entry. The superficial and sometimes more extensive injuries to which the tuber is subjected in the processes of lifting, bagging, boxing, pitting, riddling and the bruising, splitting and rubbing occurring in transport increase the liability to Dry Rot. This is again closely related to the degree of maturity of the tuber, early-maturing varieties becoming less liable to infection through

wounds after December, while late-maturing tubers remain liable until the end of the season.

Varietal Susceptibility.—Dry Rot is most frequent and severe in the early and second-early varieties May Queen, Ninetyfold, Sharpe's Express, Duke of York, Catriona and Di Vernon. Dargill Early, Arran Pilot, Arran Comrade and Majestic may also on occasion be quite seriously affected. This does not mean that other varieties are never affected but that, economically, the disease is unimportant in most of the varieties not mentioned. Gangrene has been found in most varieties but is apparently commoner in early and second-early varieties such as Arran Pilot, British Queen, Catriona, Di Vernon, Duke of York, May Queen and Sharpe's Express, and in later ones such as Ally, Doon Star, Great Scot, King Edward and Majestic.

Control.—The outline given above of the two diseases and the factors influencing their development suggests the following recommendations, which are made, however, subject to correction or modification on the basis of information that may emerge from further research.

(1) *Careful Handling.*—All mechanical injury should be avoided at all stages of the handling of the crop from lifting to storage.

(2) *Storage.*—Varieties, particularly early types that are especially liable to infection, should be stored where they can be constantly observed, i.e. in sprouting-boxes. These boxes should be inspected regularly so that diseased material may be removed and burned. The storage place should be well ventilated, cool and reasonably well lighted. All boxes that have been used to store diseased tubers and the whole of the storage place (floors, walls, ceilings, etc.) should be thoroughly disinfected with formalin (5 per cent. solution or even stronger) before they are used again for potatoes. Sufficient time should elapse between disinfection and re-storage to allow the escape of formalin vapour. Some form of gas mask is necessary when using strong formalin solutions. A less effective wash or spray is a 2 per cent. solution of copper sulphate. The store when re-used should never be damp.

(3) *Disposal of Diseased Tubers.*—These should be burnt whenever possible and only slightly diseased tubers, after cooking, should be fed to pigs. Diseased tubers or even setts cut from diseased tubers should never be planted, as blanks will result.

(4) *Treatment of Seed Tubers.*—Recent experiments have shown that infection may be reduced to a minimum by treating tubers at lifting time with various fungicides. The best of these are formalin and organic mercurial compounds, of which a number of proprietary preparations are on the market. Patent organic

mercurials should be dissolved in water so as to yield a solution containing not more than 0·1 per cent. of the active ingredient and most manufacturers' directions yield this strength of solution; the formalin solution should not contain more than 1 per cent. of commercial formalin. The tubers should be dipped for one full minute in the mercurial compound solutions but only for ¼ to ½ minute in formalin solution. The most convenient method of dipping is to place the potatoes in boxes and dip the filled box in the solution. Experiments on a commercial scale have proved that dressing of seed from ware and the subsequent dipping of the seed portion could be done on the same day as lifting. The greatest difficulty is in drying the treated seed quickly, as seed should not be bagged, boxed or clamped while still damp. The ideal method would be to use a non-poisonous dip which would remain on the tuber long enough to kill any spores of the fungi that might subsequently alight on the tubers in store. Formalin-treated tubers are non-poisonous after a short time but the treatment is not effective over a long period, while the mercury compounds are very poisonous and last on the tuber throughout the storage period. Incidentally, it is claimed that Blight in stored tubers is reduced by this method, as are Corky Scab, Common Scab and Black Scurf in the subsequent crop. "Blight" in tubers prepares the way for the entry of other organisms which may cause wet rots and is probably in this way the major cause of rots in store, hence control measures as outlined above will serve a doubly useful purpose. If organic mercurial or other poisonous chemicals are used, their storage and disposal after use under strict control is essential to safeguard the consuming public and agricultural stock.

While certain farmers claim to have controlled the disease by dusting the tubers after lifting and again when dispatching stocks with flowers of sulphur at the rate of 2 lb. per ton, controlled experiments have proved this claim to be without foundation.

(5) *Cultural Methods.*—The practice of lifting varieties a little earlier than is normal and greening the tubers on the field is regarded, with some justification, as providing them with a degree of resistance to Dry Rot infection. This is of use only where the tubers are intended for seed purposes. The control of Blight by spraying during the season or by burning down the haulms with sulphuric acid some time before lifting also provides an additional check to Dry Rot by thus preventing another mode of entry for the fungus.

MASS DESTRUCTION OF RABBITS.

It has been stated that an individual rabbit costs the country ten shillings a year. In the aggregate the total loss caused by rabbits is enormous and can be ill afforded in war time even although the flesh may be of considerable value for food. That their numbers are so great to-day is due to many factors, one of which is undoubtedly the fact that the methods hitherto employed have been based more on individual than on mass destruction. The following account describing a method which has been very successfully employed by the writer is given with the approval of the inventor—a keeper on a neighbouring estate—in the hope that it may prove of considerable assistance to landowners and farmers in other parts of Scotland.

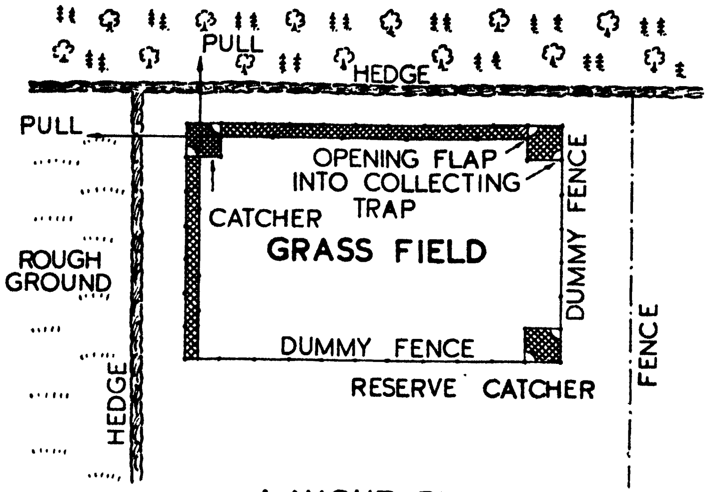
Suitable places where the traps may be set are fields bordering on woods and plantations, river banks, rocky gorges, railway embankments, dens, dunes, heaths, etc., which harbour rabbits, but from which it is necessary for them to come out to feed. If these fields are already fenced with posts and wires a considerable saving in time and labour may be effected by using the existing fences (see Figs. 5 and 6). If no such fences are available it is necessary to erect both trap fences and dummy fences as in Layout Plan (Fig. 1).

The following material is required:—

1. Rolls of $1\frac{1}{4}''$ mesh rabbit wire netting 3 feet wide.
2. Rolls of $1\frac{1}{4}''$ mesh rabbit wire netting $1\frac{1}{2}$ feet wide.[1]
3. Paling posts or stobs.
4. Staples.
5. Forestry tying wire.
6. A number of small slates.
7. A supply of wooden pegs 6 or 7 inches long. Tops smooth, notched one inch from bottom.
8. Flexible wire or strong cord for the pull.

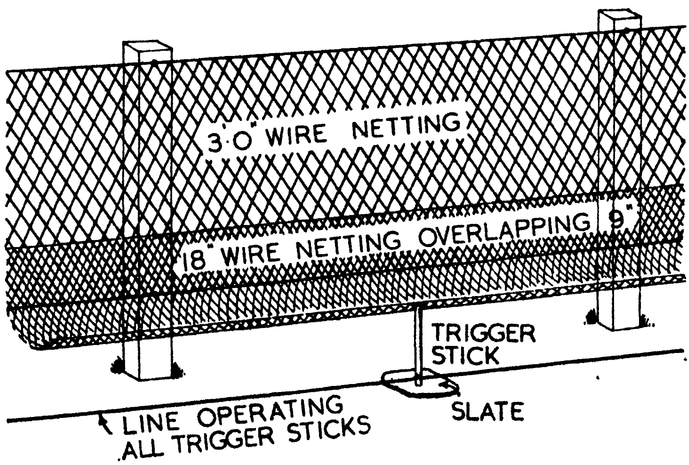
Erecting the Trap Fence.—Along the headrig of the field where the rabbits are accustomed to enter, posts or stobs should be erected as if for an ordinary wire fence. The distance between the posts should be at least seven feet. The 18-inch wire netting should now be unrolled on the ground on the field side of the posts and at a distance of three to four feet from them. When this is done the three-foot netting should be unrolled nearer the posts so as to overlap at its bottom end a breadth of 9 inches of the 18-inch netting (see Fig. 4). Where the two sets of wire netting join they should be laced together with tying wire. This is necessary, as will be explained later, to give sufficient spring

[1] If the 18-inch netting is one gauge heavier than the 3-foot netting it will snap more strongly. On the other hand, the difference in gauge may cause some difficulty in rolling the netting.



LAYOUT PLAN

FIG. 1.



PERSPECTIVE ELEVATION OF TRAP
OPEN

FIG. 2.

for the lower wire. The laced wire netting is now securely nailed to the stobs in such a manner that at least six inches of the lower wire sweeps along the ground. The bottom staples securing the two-ply portions of netting should be about five or six inches from the ground. Difficulties with bends or uneven ground can be avoided by pegging down the trap permanently for the necessary distance and by passing the pulling wire round a post set outside in the direct line of the pull.

The flap of the 18-inch wire netting is now propped up off the ground by pegs at a sufficient height to enable the rabbits to pass freely under the netting on their way to and from their feeding ground, care being taken not to spoil a run (see Figs. 2 and 3. The representation of the wire netting is diagrammatic).

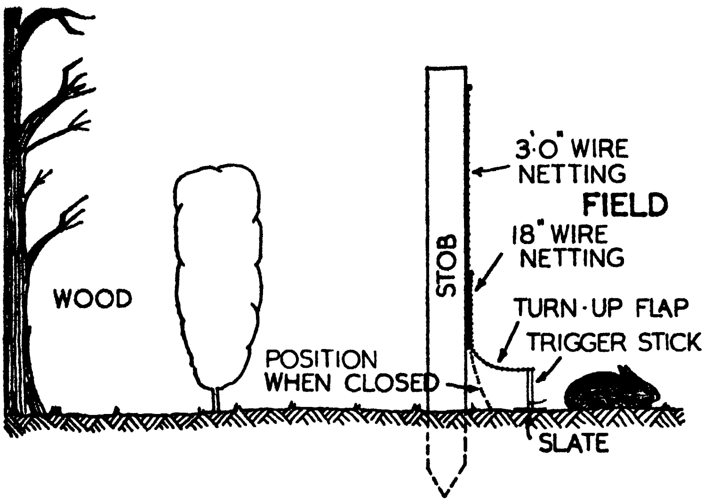
Erecting the Dummy Fence.—When this has been done the remaining part of the field should be closed by erecting a light, temporary rabbit-proof wire netting fence. If the field is very large it may be desirable to erect an interior fence just beyond the limits of the usual feeding ground to stop breaking back.

Rabbits will very soon resume their normal habits, becoming familiar with the slates and cord and entering the field underneath the flap. At an opportune moment, when most of the rabbits are feeding, the flap should suddenly be allowed to drop on to the ground. All exits are then closed to the rabbits.

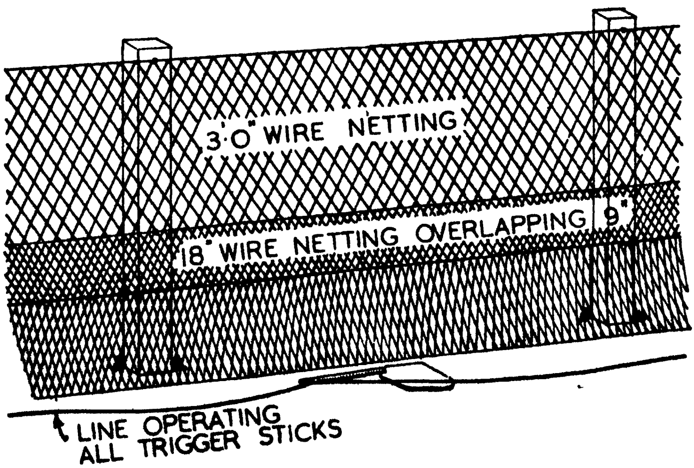
In order that the impounded rabbits may be easily taken, wing wire catchers should be erected at the points where the wing of the dummy fence meets the trap fence. These allow the rabbits to enter but not to leave. To prevent rabbits escaping at the corners by piling up and jumping the fence, care should be taken to have these roofed over with netting wire. The man entering the killing pen should be careful to close a flap behind him.

Final Setting of the Trap.—Good results ought to be assured after ten or fourteen days. On the morning of the day when operations are intended to be carried out the temporary supporting pegs should be replaced by pegs to which a pulling cord or wire is attached.[2] This cord or wire should be fixed to the peg by a clove hitch about an inch from the bottom. By placing the lower end of the peg on a slate the peg slips easily when the cord is pulled. The top end of the peg should lean slightly away from the direction of the pull and just support the outer edge of the wire. When the pegs slip the double ply of the netting wires acts like a spring and the flap of the wire comes firmly down to the ground. In placing these supporting pegs in position care should be taken

[2] The pegs with cord attached should be placed in a handy position when the fence is erected, so that the rabbits may become familiar with them. To introduce the cord only on the day on which it is to be used might spoil the scheme.



SECTION SHOWING TRAP
OPEN
FIG. 3.



PERSPECTIVE ELEVATION OF TRAP
SHUT
FIG. 4.

to have only one between each two posts. The end of pulling wire or cord should be run out to a point well clear of the field to which the operators may approach unseen and unheard.

The Pull.—One sharp pull ought to release the spring; if more than one operator is required the simultaneous pulling of the cords or wires can be effected by acting on a whistle signal. Once the cord or wire is pulled immediate steps should be taken to see that there have been no hitches and that the whole of the netting is lying close to the ground so as to prevent any rabbits escaping underneath. (See Fig. 4.) When this is done the beaters may be started. Since the full use of torches and bicycle lamps is ruled out in war time, dogs and switch lines ought to be employed. Usually, however, the majority of the rabbits make a dash for home only to find that their retreat is cut off. The rabbits can easily be driven into the wing catchers where they can be taken.

It is wise to go over the ground again the following morning to see that no holes, which ought previously to have been ferreted and blocked, have been re-opened. If the field is not required immediately for grazing the trap may be re-set and pulled again after a suitable interval. Otherwise it can be taken down and re-erected in another field.

Experience has shown that two men can erect a complete 300-yard trap in the course of a working day, and considerably more on existing fences.

Four hundred and eleven rabbits have been taken in a single night. Good clearances of young and old can be made in summer evenings.

The Agriculture (Miscellaneous War Provisions) Act.

This Act, which received Royal Assent on 21st March, amends the Wheat Acts and the Agricultural Development Act, and also includes some new matters of importance.

Part I. deals with wheat. Section 1 provides for accounting periods of less than a year for the reckoning of deficiency payments, and for full payment irrespective of the total amount of millable wheat sold during the cereal year; Section 2 raises the standard price per cwt. to 11s. and gives the Minister power to vary this by Order; and Section 3 suspends the making of quota payments on flour, deficiency payments being made from the Exchequer. These arrangements are to hold good during the "period of suspension," which is to come to an end not more than two years after the end of the war period.

Part II. is concerned with the other cereal crops and with ploughing. By Section 8 the lower rate of subsidy payable to a person claiming wheat deficiency payments in respect of the

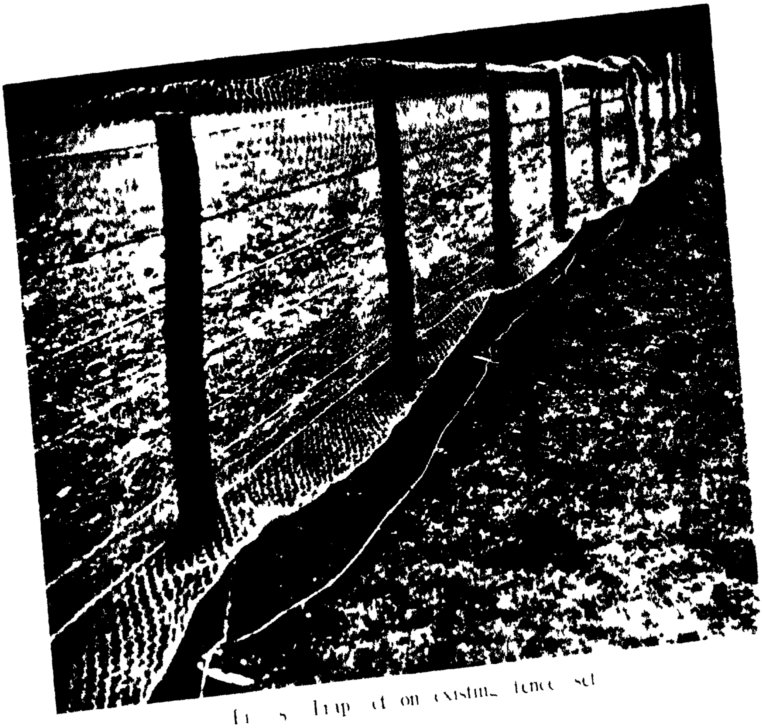


Fig. 5 Trap set on existing fence—set

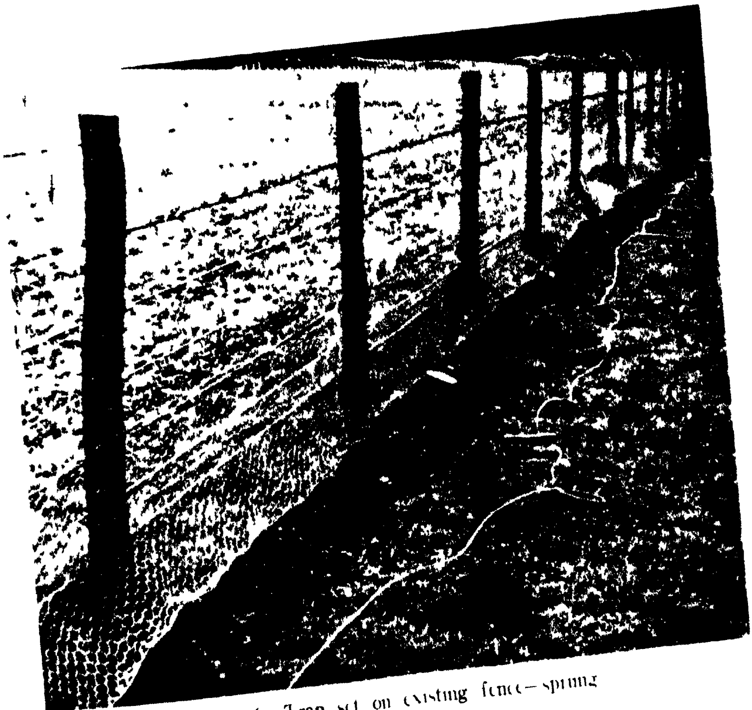


Fig. 6 Trap set on existing fence—sprung

holding concerned is abolished. The subsidy on oats (if any) payable in respect of the 1940 and future crops will in all cases be 14 times the difference between the standard price and the United Kingdom average price per cwt. The reduction made in the rate of subsidy in the event of the qualifying acreage of oats exceeding a certain amount is also abolished. Section 9 brings in rye for subsidy as if it were oats, and certain provisions regarding mixed crops are made in the Third Schedule. Section 10 abolishes the reduction made in the rate of subsidy on barley in the event of the total crop exceeding a certain amount.

Section 11 gives the Ministers power by Order to extend the ploughing grant scheme to anv year wholly or partly within the war period; makes grants payable in respect of land improved by re-seeding to grass; reduces the minimum qualifying area from two acres to one; and brings in parcels of land not comprised in a farm, but extending to at least one acre. Section 12 empowers a Common Grazing Committee to make a collective application for a grant in respect of land comprised in a township, the grant to be apportioned among the landholders according to the areas ploughed up on their respective holdings.

Part III., dealing with drainage, applies only to England and Wales.

Part IV. is headed "Miscellaneous and General."

Section 23 lays down the procedure to be followed when the Secretary of State or an Agricultural Executive Committee has taken possession, under the Defence Regulations, of land not cultivated at all or not cultivated in accordance with the rules of good husbandry.

Section 24 provides for the ante-dating by an Agricultural Executive Committee of directions to plough up land (in cases where the ploughing up was begun after the outbreak of war but before the directions were actually given) for the purpose of determining the rights and liabilities of the landlord and tenant of the holding concerned.

Section 26 excludes certain holdings from the Agricultural Holdings (Scotland) Acts (in certain circumstances arising out of the cultivation programme).

By Section 27 the Land Fertility Scheme is extended to cover gardens.

Section 28 relates to the importation of cattle.

Section 29 provides for "The cleansing of channels and watercourses in Scotland." Its purpose is to prevent injury to land caused by the failure of the owner or occupier of other land to cleanse or scour a watercourse in or adjoining the land concerned or to join in doing so. In such cases the Secretary of State, on consideration of a report by an Agricultural Executive Committee, may serve a notice on the persons concerned to do what is

necessary. If he fails to do so, the Secretary of State may carry out the work and charge the cost to him or allocate it beween him and any other person responsible for neglect. An appeal may be made to the Land Court against such assessment.

Section 1 of the Land Drainage (Scotland) Act, 1930, was intended to provide a remedy in such cases. The procedure now proposed will, it is hoped, prove more effective.

Lastly, Section 25 enables the Secretary of State to make "arrangements for providing goods or services to persons requiring them for agricultural purposes." The object of this provision is to furnish farmers with short-term credit for the purpose of carrying out their part of the programme of increased production of food.

Copies of the Act may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh, 2, either directly or through any bookseller, price 6d., or by post 7½d.

Other Acts of Parliament.

Among emergency Acts of Parliament of interest to farmers are (1) The Compensation (Defence) Act, which provides for the payment of compensation to the owner and occupier of land or other property occupied or requisitioned during war; (2) The War Damage to Land (Scotland) Act, which limits the liability of tenants and the rights of creditors; and (3) The War Risks Insurance Act, from the compulsory provisions of which farmers are by Order largely exempted.

The Land Cultivation Campaign.

Before the war broke out, plans had already been made by the three Agricultural Departments of the United Kingdom, in consultation with the Food (Defence Plans) Department of the Board of Trade, for a large increase in the area under the plough. Scotland's share was fixed at 260,000 acres, the total for the United Kingdom being 2,000,000 acres.

When the tillage area in Scotland in recent years is compared with that of 20 to 25 years ago, it is seen that a large decrease has taken place. This is shown in the following table :—

Year	Tillage		Rotation Grass		Permanent Grass		Total Crops and Grass	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1913	1828	100	1474	100	1496	100	4798	100
1918	2099	115	1354	92	1308	87	4761	99
1923	1792	98	1506	102	1426	95	4724	98
1928	1627	89	1506	102	1532	102	4665	97
1933	1553	85	1477	100	1584	106	4614	96
1939	1480	81	1455	98	1623	109	4558	95

(a) Area in thousands of acres: (b) index number (1913 = 100).

Leaving aside the exceptionally large acreage brought under the plough in 1918, it will be seen that the achievement of the programme for 1940 would still leave it at a lower figure than it reached in 1913 and in 1923.

It was recognised, however, that apart from bringing land under the plough there was urgent need for the improvement of much of our poorer grassland. In order to assist farmers to improve the productivity of such land there had already been in force since 4th May, 1939, a scheme for the payment of a grant of £2 per acre for the breaking up of land that had been under grass for seven years or more. The object of this scheme was to encourage farmers to carry out work which was in any case desirable in order to convert this land into more productive pasture, and which would, if the need arose during the autumn or the following spring, enable the land to be readily used for growing food or fodder crops.

This scheme was at first to be in force until 31st October, 1939, but its period has been extended by successive steps to 31st March 1941, and the conditions have been modified to provide that, as a general rule, the land must be devoted to an arable crop. The minimum area eligible for grant was reduced to one acre, and it was announced that in crofting townships having Crofters Grazings Committees the land of the township would be treated as a single unit for the purposes of the scheme.

Arrangements were made in the summer of 1939 for the constitution, in case of emergency, of Agricultural Executive Committees throughout Scotland to carry out the scheme for increased cultivation of crops and to undertake other war-time work. Accordingly, on 4th September the Secretary of State constituted these Committees, and made the Cultivation of Lands (Scotland) Order, delegating to them certain powers under the Defence Regulations.

There are 40 Committees, about half of which are concerned with single counties, while the larger counties are divided between two or more Committees and some of the smaller ones are combined. The officials of each Committee comprise a Chairman designated by the Secretary of State, a Secretary (generally a local man of business), and an Executive Officer (generally a member of the staff of one of the Agricultural Colleges), whose duties are to give technical advice and to see that the work undertaken by farmers is carried out. Members of the Department's technical staff have been appointed to act as liaison officers between the Department and the respective Committees and to render technical assistance of various kinds.

The additional acreage to be cultivated had been allocated among the various Committees, and their first task was to make

a survey of their respective areas, to guide them in assigning a certain acreage to each farmer. In order to facilitate their task, the Department furnished them with a form for each holding, showing the acreage of crops and the numbers of live stock at 3rd June, 1939, and providing space for reports on other subjects. The issue of some 68,000 forms was completed by the Department on 21st September.

The receipt and examination of intimations of intention to plough up grassland under the scheme was transferred by the Department to the Committees on their constitution, as this naturally fitted in with the scheme for increased cultivation.

The Committees and the farmers concerned entered energetically on their heavy task. Up to Christmas the campaign was favoured with suitable weather, but thereafter a spell of frost unparalleled for 45 years set in, accompanied in many parts by abnormal snowfalls. Great arrears of work accumulated in January and February, but when the weather conditions became more favourable the task was resumed with vigour, and work was pushed on in a way that reflects the utmost credit upon farmers and farm workers alike.

Supplies of Agricultural Requisites.

Feeding-stuffs.—At the outbreak of war a Feeding-Stuffs Control Board was appointed, on which the Department were represented, and County Feeding Stuffs Committees were set up throughout Scotland. Prices were temporarily fixed at the pre-war levels, and throughout September and October few complaints of shortage were made.

At the end of November, however, the Minister of Agriculture and the Secretary of State made a joint announcement that owing to shipping difficulties it was necessary to reduce the consumption of feeding stuffs. Every effort would be made to maintain adequate supplies for dairy cows, beef cattle and sheep, but keepers of pigs and poultry were advised to plan for the next twelve months on the basis that feeding-stuffs would be reduced by at least one-third. This was followed by advice to poultry-keepers to cull their flocks rigorously. A higher scale of prices for feeding stuffs came into force on 8th January, 1940, and a further statement was made by the Ministers on 2nd June to the effect that keepers of pigs and poultry might have to reduce their stocks to one-third of their present number by the autumn.

Fertilisers.—Prices were stabilised as at 3rd September, 1939, and small increases were made from time to time by the Minister of Supply after consultation with the Department. Supplies were on the whole well maintained.

Seeds.—Supplies of wheat and barley seed were adequate, and there was a certain surplus of oat seed. Grass and clover seeds were generally sufficient in supply, and steps were taken to make good certain deficiencies by means of imports from selected countries.

The Department collaborated with the Ministry of Food in the preparation of the Seed Potatoes (Maximum Prices) Order of 29th November, 1939, which prescribed top and bottom riddles as well as maximum prices for the different varieties.

Machinery and Implements.—Arrangements were made for a supply of 300 tractors, with corresponding numbers of ploughs, etc., to be kept for carrying out work where farmers were insufficiently equipped. The scheme was directed by Mr R. D. Ewart, who filled the same position during the last war. Applications were made through the Agricultural Executive Committees, and the arrangements were carried out by them through the agency of local engineers. A range of rates of payment was prescribed to the Committees. There was little demand for the services of these tractors up to Christmas, but after the frost was over they were in greater demand to overtake arrears of ploughing.

The Department's orders for machinery were restricted so as not to interfere with orders placed by farmers.

Timber.—In order to distribute fairly the reduced supplies of timber available, the Ministry of Supply introduced a scheme whereby timber was rationed to Departments and could not be released for use without the authorisation of the appropriate Department. An appropriate quota was allotted to the Department, who were responsible for pre-war Land Settlement schemes and for rural housing and public works in the Highlands and Islands. Further supplies were made available for the repair and extension of farmhouses and steadings and for the manufacture of agricultural machinery and implements.

Miscellaneous.—The Department made representations from time to time regarding supplies of steel, corrugated iron, wire, cement and other materials for agricultural purposes.

Ammunition.—The supply of ammunition for killing deer was facilitated by arranging for one type of bullet to be supplied for rifles of each calibre.

Supply of Labour.

The special needs of agriculture were recognised by the inclusion in the Schedule of Reserved Occupations of most of the classes of agricultural workers over 21 years of age. In four of the more important occupational groups the age of reservation has recently been reduced to 18.

Special steps were, however, taken by the Department to ensure an adequate supply of workers in view of the call for increased cultivation. They obtained the release of soldiers from local units to help with the 1939 harvest, and this concession was extended to 31st December. Applications were invited, as the successive groups were called up for military service, for the postponement of the calling-up of men under 21, and arrangements were made under which the periods of postponement granted could be extended. A limited number of "key" men serving in the Forces have been released, temporarily or permanently, irrespective of age.

The Women's Land Army was organised before the outbreak of war, and the latest returns show that nearly 400 of its members are in agricultural employment. Their services have been highly appreciated by the farmers employing them.

Arrangements have been made for students and schoolboys to assist in the work of harvest, and several hundreds of applications for enrolment in the Women's Land Army Auxiliary have been received for service of from four weeks to several months.

By virtue of the Undertakings (Restriction on Engagement) Order, which came into force on 10th June, no employer can engage any male worker normally employed in agriculture except for work in agriculture unless the engagement is made through an Employment Exchange. A similar restriction applies to future engagements of male workers now employed in other industries, but holding unemployment books showing that they were formerly engaged in agriculture, unless their re-engagement in their new industry takes place within a period of not more than fourteen days.

Deer, Hares and Rabbits.

An Order was made by the Secretary of State on 2nd November, 1939, giving the occupiers of agricultural land the right to protect their crops against damage by deer, while under the Defence Regulations the Agricultural Executive Committees may by Order authorise persons to enter on specified land for the purpose of killing or taking deer.

A Deer Control Officer was appointed by the Department to act as liaison officer between them and the Committees in this matter and also in the organisation of the disposal of venison for food.

Steps were also taken to further the use of suitable land in deer forests for grazing.

An Order was also made extending the right to kill hares and rabbits conferred on occupiers by the Agricultural Holdings Acts, and the Committees received power to authorise persons to enter on land for this purpose.

Publications.

On 4th October 1939 the Department issued the first number of *News and Notes for Farmers,* with a message to farmers in Scotland from the Prime Minister.

This was a cyclostyled pamphlet of 12 to 15 pages, containing official intimations and notes on agriculture and animal husbandry, and it was issued weekly to the members and officials of the Agricultural Executive Committees, to other official bodies and to the press, some 1200 copies being circulated.

In the middle of March it was replaced by *Notes for Farmers,* printed and issued fortnightly free of charge to all applicants. By that time the element of "news" had become of less importance, and the paper in its new form consists almost wholly of short articles on matters of current interest in agriculture and animal husbandry, contributed mainly by members of the staffs of the Agricultural Colleges and Research Institutes, and also by farmers who describe particular operations that they have successfully carried on. The circulation is now over 5000.

The Department have also issued "Scotland's War Gardens," a guide to allotment-holders and private gardeners on the growing of vegetables, to be obtained from H.M. Stationery Office, price 3d., and the following War Pamphlets :—

No. 1. Manuring of Gardens and Allotments.
" 2. Economy of Foodstuffs in Pig Farming.
" 3. Home-grown Foodstuffs for Milk and Beef Production.
" 4. The Bottling of Fruit.

Copies of Nos. 1, 2 and 3 may be obtained free of charge on application to the Secretary, Department of Agriculture for Scotland (Room 034), St Andrew's House, Edinburgh, 1. The price of No. 4 is 1d. per copy, 9d. per dozen and 4s. per 100 (H.M. Stationery Office).

The Ministry of Agriculture and Fisheries have issued a large number of "Growmore" leaflets. The following are some of the titles :—

No. 3. Making the Most of Potash Supplies.
" 4. Rye as a Grain Crop.
" 6. Growing two Corn Crops in Succession.
" 10. Unsaleable Potatoes : Their Use in Animal Feeding.
" 11. Pests and the Breaking of Grass Land.
" 12. Economy in Horse Feeding.
" 16. Wood Pigeon Shooting.
" 21. Emergency Weather Forecasts.

No. 28. Ensilage in War Time.
„ 30. Preparation of Bordeaux Mixture and Burgundy Mixture in Small Quantities.
„ 37. Manure from Garden Rubbish.

Residents in Scotland may obtain one copy of each of these free of charge on application to the Department as above.

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MESSAGE FROM THE PRIME MINISTER

THE story of Scotland is, in many of its most stirring chapters, the story of her fight for freedom. It is for freedom that she has been ever ready to strive grimly, to endure stoically, and, when need was, to pour out her best blood. The chapter that is now being written, and that forms part of the great book of the British Empire, will be no less heroic than those that have gone before. It is being written by her men on the battle fronts, and by her men and her women in factory and workshop, on farm and croft. It is to these last, the farmer and the farm-worker, that I speak now. The value of their service in the struggle can hardly be over-rated. The people must be fed, goods and munitions of war must be imported, ships and the sailors that man them must be saved. To that end, the fields of Scotland, tilled by a hardy and industrious race, must give of their best. I am confident that they will. The men and the women on the land of Scotland must toil as they have never toiled before, for never has a sterner or a nobler task been set them. The Government has said that agriculture will have its fair place in the national economy, and has said so in the firm belief that those to whom I am now appealing will put forth their utmost strength, forgetting the huckstering and bargaining of the market place, and thinking only of the ultimate victory which our united efforts will surely achieve.

My message is this: You have already done well; go now and do still better.

Winston S. Churchill

HOW TO INCREASE FOOD PRODUCTION.

THE contributors of the following short articles, which are printed under their respective authors' names, were invited to give briefly their views on the means by which food production in Scotland may be further increased. The Department acknowledge gratefully the ready response which all these writers made to their request. The publication of their views in the *Journal* does not necessarily imply official agreement with them.

SIR THOMAS H. MIDDLETON, K.C.I.E., K.B.E., C.B., F.R.S.

In peace the farmer has to struggle—and in recent years the struggle has been hard—to maintain himself and his dependents, including those whom he employs. In war the struggle continues, but his main objective becomes the defence of his fellow countrymen, as well as of his own folk, from the dangers that threaten all alike. He and his men occupy a front place in the ranks of our civil defenders. The ordinary standard of success, the profitableness of his business, though still important to himself and the nation (since money enables him to intensify his production) can no longer be accepted as the first measure of his value. As a member of our defence forces, he is judged by the contribution which he makes to the food supply.

The value of this contribution can be measured neither in terms of pounds sterling nor pounds avoirdupois; what we want to know is the intrinsic value of the produce of each acre, or hundred acres, of his holding in sustaining people in health. It is partly because a new standard has to be applied by the authorities in measuring his success that the farmer so often finds the action of Controllers incomprehensible. It is not surprising that he is puzzled, for Controllers themselves are faced with a perplexing task in deciding just what is most wanted. That is not only because their most careful plans may be upset by enemy action, but because food has several functions to serve. So that the body may be built up and repaired, food must supply the materials for its tissues; so that bone may be formed there must be minerals; so that the body "machinery" may operate smoothly there must be vitamins; and when the "machine" has been provided for there must be fuel (*i.e.* energy) to enable it to do work. All our ordinary farm products, except sugar, which provides the last only, supply more or less the four groups of constituents needed by the body. When an attempt is made in war-time to assess the value of the land's output to the nation, it is necessary to stipulate in the first place that a sufficient supply of all constituents must be provided, and then, so that we may have some common measure of comparative value, to ask whether any one group is so important that

it may safely be used as a standard by which to value the land's output.

It will generally be agreed, I think, that, assuming precautions are taken to guard against deficiencies of other constituents, a good standard by which to gauge the farmer's success in war farming is his land's output of those constituents in food which provide energy. Apart from water, from 80 to 90 per cent. of the weight of the nutrients required by the body are energy producers. In war, when strenuous bodily work is necessary, the need for those foods which make work possible rises sharply, and, just as the most powerful motor car will not travel a yard when the petrol tank is empty, so the finest troops and the most skilled and industrious munition workers could carry on no longer if the supply of energy were to fail Though Göering may choose to forget it, it was not the want of guns but of butter, and energy foods like it, that made Germany sue for peace in 1918.

Bearing in mind the fact that in normal times about two-thirds of the supplies of the energy foods we require come from overseas, and that war has greatly increased our needs, it is apparent that to-day the farmer's most important task is to increase the land's output of food producing energy.

To what extent this may be necessary we cannot yet say. We imported about 20,000,000 tons of food and feeding stuffs before the war. In 1917 our imports had been cut down to about 14,000,000 tons, and in the autumn of 1918 we were faced with the prospect of getting little more than 10 to 12 million tons should war continue. No such cuts in our imports have been necessary in the past year, but anyone who compares the present situation with that in the last war is likely to agree that, in the matter of their rations, our people and our livestock will be fortunate indeed if they fare no worse than they did in 1918.

This being the position, those of us who, as farmers, are accustomed to planning our work two years ahead, must agree that, while doing all that is possible for 1941, we must be ready, should the necessity arise, to meet restricted imports by further increasing the land's output of energy foodstuffs.

In planning for the future, there is only one other major problem: the supply of liquid milk, especially the winter supply, must be safeguarded. Milk is but a moderate source of energy, but its value for other reasons is so great that it should take precedence over other foodstuffs.

Among farmers themselves the relative merits of two methods of increasing food production are much debated. When in 1914 our 99-year lease of peace ended and war's novel problems confronted us, one method only got much attention. We had been farming reasonably well in the preceding years, but it was clear

that, without altering our long-established system of husbandry, we could improve our practice. "Farm your land better" was the slogan everywhere adopted in 1914, and it took more than two years of effort on the part of some of us, who urged a change of system—the conversion of permanent grass into arable land—before support was gained for a national ploughing campaign. In 1939 there was no such delay; with the experience of the last war available the plough was set to work at once, and in the past year it has been busier than ever before throughout the United Kingdom. Yet there are still among us not a few who maintain that, if all our efforts had been concentrated on the better farming of existing arable land, the good harvest of 1940 would have been better still.

I am far from undervaluing the possibilities of better farming; that there is abundant need for it all who know the countryside can see for themselves. There is no lack of experimental records to show what might be done by more liberal manuring. Sodden fallows and unhappy spring corn almost shout for draining. On paper, indeed, there is no difficulty in showing how much more our arable land could do. And yet there is enough experience available from those who have tried it, to prove that the re-conditioning of badly farmed arable land is no rapid or easy business. Fifty years ago, anyway, in my part of Scotland, that was the progressive farmer's accepted view; thus, when a skilled man took over the nineteen-year lease of a badly neglected holding, his neighbours were prepared to allow him six or seven years before passing verdicts on the success or otherwise of his operations.

It may be granted that active War Committees can do much, but under war conditions, with labour and supplies of all kinds difficult to provide, they would be successful indeed if they were to increase the average output of arable land by 10 per cent. after two years of effort. In a favourable season they might perhaps hope for some such result in a single year, but War Committees, like others, must take the seasons as they come.

As compared with the results to be expected from the better management of existing arable land, what are the additions to the nation's supply of energy-yielding foodstuffs that may be expected from the conversion of grassland into arable?

At best, the output of energy from grassland is low; a hundred acres of our finest pastures could provide for the annual needs of perhaps 40 to 45 persons, pastures of average quality for some 9 or 10, and very poor grassland for one or two only. In the case of milk-producing pastures the variation is less and the average output better, but only under exceptional conditions could the needs of 60 or 70 persons be provided for, and the average would be round about 40.

Apportioning, in accordance with their size and number, the permanent grassland of England and Wales between meat- and milk-producing livestock, I estimate that just before the outbreak of war one hundred acres of grass provided for the maintenance of 20 persons. Calculations of the same kind show that ordinary arable land moderately farmed on a four-course rotation would provide for about 75 persons; good arable land along the east coast from Ross-shire to Kent would usually show a figure of 80 persons per 100 acres, and there must be many farms in the eastern half of Britain which provide the annual energy needs of 120 to 125 persons per 100 acres.

I have estimated that before the last war the cultivated land (grass and arable) of Germany supported from 70 to 75 persons per 100 acres. I have made no later estimate, but think it likely that in the years before the outbreak of the present war the figure had risen by 25 at least.

Germany did not forget, as we did, the experiences of 1914-1918. Our new tillage land rapidly reverted to grass; there the permanent grass area, then much smaller than ours, has become smaller still. This is the principal, but not the only reason why so large a population is fed by her soil, nor is it that German tillage land is better farmed than our own. The second circumstance explaining why it is that German soil feeds so many more than British has nothing to do with farming; it concerns the consuming public. Germany has many skilled stock-owners, and the Nazis, who feed their people on livestock principles, have made full use of the knowledge available! Broadly, the aim has been to maintain health at the lowest cost. "Store," not "fattening," rations are prescribed, but before the war without complete success. Germans are now learning from their masters that they are too fond of unnecessary fats. "Guns for Butter" was a slogan into which military and dietetic considerations both entered. If our consumers had to eat what was ordered, and at the time of year when the commodity was plentiful, much of the difference between the number of persons supported by German and by British farming would disappear.

But to return to our own country, the figures given above show that, by ploughing grassland which is suitable for tillage, a large increase in the kinds of food essential for our people in war could be secured. The type of land suitable for ploughing might be expected, while in grass, to provide for rather more than the 20 persons per 100 acres which I estimated to be the average output of all grassland, but it would be unlikely on the average to provide for more than 25 to 30.

Thus, from every acre of permanent grass successfully converted into arable land, a three-fold increase may be expected as

compared with the 10 per cent. increase which might be hoped for from the better farming of existing arable land.

It is not enough, however, to stress the possibilities of increase. Unless grassland for breaking up is carefully selected and reasonably well managed, no such three-fold increase could be looked for; the returns from ploughing might not justify expenditure in labour and seed. It is this, the failure to choose suitable land, that gives point to the criticism of those who would prefer to rely wholly on "better farming." Even where the land itself is suitable, and the management has been good, failures must be reckoned with because of wireworms, leather jackets, and other pests; this has to be admitted, but in war risks of this last kind should be taken.

The total area under crops and grass in Great Britain in 1939 exceeded 29,184,000 acres; of this total an area of over 17,234,000 acres was under permanent grass; the latter has since been reduced, but over 15,000,000 acres still remain. The scope for selection is therefore large, and as from season to season War Committees gain in experience, I see no reason to fear that from every thousand acres which they break up the return would be less than three-fold.

While we do not yet know how much additional grassland necessity may compel us to plough, we cannot begin too soon to search for and select land that could be broken up with reasonable prospects of success. Hitherto most of the land recently ploughed up had been tilled in 1918, and selection by Committees has presented relatively little difficulty, but now more than half the area that reverted to grass after 1918 has again come under the plough; thus the task of selection becomes more difficult and, it may be added, more urgent as the months pass.

It is natural that the ploughing of large areas of grassland should cause misgivings to stock-owners who depend so largely on grass and hay for their livestock; but if necessity were to force us to plough up one-third of what now remains, there would still be left enough to safeguard the dairy herd—which must be a prime consideration with War Agricultural Committees—and to maintain other essential stock. There is great scope for improvement in the management of our grassland, and its stock-carrying capacity could much more easily be increased than could the average yield of tillage crops. Nor should it be forgotten that, if tillage reduces the area under grass, the stock-carrying capacity of the land, even in summer, is not correspondingly reduced; for most of the temporary leys of the arable farm would be much more productive than the old grass which had been broken up.

But on the possibilities of grassland improvement others will write. My purpose is once again to stress the importance of tillage crops to the nation in war.

Against a plough policy it may be claimed that the position now is very different from what it was in the last war. In one respect this is true. In 1916 the United States, Canada and Argentina harvested three-fourths only of the grain crops they had garnered in the previous year, and our own potato fields had produced about half a crop. Now the stocks of breadstuffs within the country are large, and the grain silos of America are full to overflowing.

Although there is no scarcity of food, the need for economising shipping space and money is nevertheless as pressing as before, and the outlook for the future is as uncertain; thus in framing a food-production policy it is just as important to look at least two years ahead as it was in 1916. It is not possible to predict the demands which will arise in later years, but as the selection of land for ploughing involves much work, it should proceed continuously. Possible future, as well as immediate, requirements for more tillage could be met by arranging the land examined in classes to be "called up" for active service in food production as needs dictate.

I commend as a war motto for food producers one which I first learned well over sixty years ago. It is a motto which many Scotsmen would recognise as that of their old school,

"Ready, ay Ready."

SIR ROBERT GREIG, M.C., LL.D.

Although the greater part of any increased production from the land must be got from existing and reconditioned farms, an important contribution can be made by gardens and allotments. This contribution is of particular value, for, whereas the farmers must find additional labourers to increase supplies, the occupier of a garden or allotment gives his spare time or leisure and that of his family to the food campaign. Thus there is no extra draft upon labour, and all garden and allotment produce is, as it were, a net profit to the country. This is encouraging to the cultivator, for he knows that every potato, carrot, or other edible vegetable which he grows is of direct assistance in winning the war.

It is scarcely necessary to dwell on the nature of such assistance. Owing to the occupation of Denmark, Holland, Belgium, and the Channel Islands, an important supply of foodstuffs has been cut off. To meet this deficiency the butter, eggs, bacon and other products which came from these countries must now be imported from long distances, and the supplies of fresh vegetables lost from these sources must be grown at home. Long distance, involves a much greater provision of tonnage for food, and reduces

the shipping space available for munitions and for raw material in general.

It is hoped that the gardens and allotments of Scotland will produce food which will save three-quarters of a million tons of shipping space in 1941.

To bring this about, the Scottish Gardens and Allotments Committee has attempted a scheme of organisation covering the whole country, and, thanks to the enthusiastic voluntary help received from all sides, the arrangements are working well. By this organisation it is possible for the Committee to help to remove difficulties in the acquisition of land; to secure the benefits of its contacts with seedsmen, fertiliser manufacturers and others; to arrange for the circulation of information, and for the advisory services of the Colleges and of horticultural experts.

The arrangements made are designed to encourage the utmost extension of vegetable production by family units, and at the same time to safeguard the provision of the essential foods of special value for health.

Vegetables have become a front line of our defence. Two of the crops which give the highest yield of food per acre are vegetables and potatoes. Both crops can be produced in plentiful supply by family units for domestic requirements in well-worked gardens and allotments for a trifling outlay.

As regards nutritional needs, these foods are supremely important to ensure a state of physical fitness, and the Committee aims at a minimum consumption of 6 ozs. per head daily of fresh vegetables. To eat wisely what is grown, and to avoid needless waste is, however, just as important in the public interest as plentiful production. The task of the Committee in stimulating the production of sufficient amounts of cheap vegetables depends for its fulfilment on a knowledge of nutrition in every household, and the gradual removal of prejudices which obtained under peacetime conditions is now being effected as a result of the intensive propaganda conducted by the Ministry of Food in association with National Colleges of Domestic Science, local Education Committees and other interested bodies.

SIR JOHN H. MILNE HOME, Canonbie, Dumfriesshire.

The question "How best can food production be increased?" is a subject upon which much has been written during the past year, and there are so many aspects that it is only possible in short space to refer to one or two of them.

Increased food production is by no means merely a matter of acreage, nor is it entirely dependent upon the application of manures to increase yield per acre. One of the most valuable, although

the least spectacular, forms of increased production is the elimination of waste to the utmost possible extent.

The crops grown for human and animal food suffer a loss through waste almost from the date the seed is sown. The sowing of seed either too thick or too thin is in itself wasteful. Failure to keep crops clean and free from weeds, failure to cultivate every part of a field which is capable of being cropped, involve loss. The loss of a three-foot strip round a ten-acre field means a fifth of an acre. How often are odd corners or end riggs left uncultivated in order to avoid a little trouble. Such ground is not only lost to cultivation, but it grows weeds which seed.

Failure to cut and harvest a corn crop just at the right time may mean the loss of several bushels per acre when threshing time comes. The weather conditions last winter resulted in the loss of thousands of tons of turnips that had not been protected or stored. Such mishaps may be due to weather, but very often they are due to lack of energy and foresight.

In pastures the loss of grazing from thistles and other weeds is much greater than is commonly believed. The productiveness of pasture growing on a soil sufficiently supplied with lime and phosphates may be four times as great as on pasture deficient in these minerals. On hill pastures the loss of grazing due to bracken is well known.

The use of implements and machinery that are worn out or in need of repair may result in delay and loss of crop.

The crops produced on the farm or market garden cannot be said to be truly utilised until they have been consumed as human food or as feeding stuffs for stock. That is the point at which production should be measured. Ill-balanced rations for stock, feeding too much or too little, are forms of waste not so easily checked.

Nor should the damage done by rats, mice and other vermin be overlooked.

Where stock is being kept under unfavourable conditions of soil or of housing, a high death rate may result, or at the least unthriftiness, which is another form of waste.

It is a function of good management and of farming skill to minimise these forms of waste to the greatest possible extent, and so to increase production. It is doubly important at the present time to pay full attention to such details. The difference between the well-managed farm and the carelessly managed farm alongside it is sometimes very striking.

It is an important part of increased food production to endeavour to bring up to the higher standard as many holdings as possible.

SIR JOSHUA ROSS-TAYLOR, Duns, Berwickshire.

The casual response to the question "How best can food production be increased?" would probably be: "plough more land."

After two plough campaigns under exacting executive committees, the more suitable cropping land in my district is now all scheduled for approximately one-half in grain and one-quarter in roots for 1941—an exhausting rotation for much of our land in the Border area. Should a further call become necessary, "plough more" hardly meets the situation, for recourse would have to be made to higher and less productive districts—more frequently a liability than an asset. If needs required cropping in the uplands, committees would have to see to it that the most suitable fields were taken.

Fortunately we do not start from scratch, for probably one-third of the total area to be cropped in 1941 has lain for lengthened periods in ley; in consequence, there is a vast store of accumulated fertility to draw upon. Such fields, in general, ought to yield maximum grain crops for two seasons, with the assistance in some cases of a light dressing of artificial manure, and, if necessary, some ground lime. Recognised practical difficulties at once arise if such a practice has to be extended further. Land becomes foul, manurial requirements become heavy to maintain the full crop which is essential, while so large a cereal area cannot now be effectively handled in roots the following season. For the other two-thirds of our tillage land a manurial dressing when necessary would do much to raise production in part, but many fields are already at a maximum, and any attempt to raise the yield would end with laid crops and reduced yield.

With greatly increased acreages of straw and root crops material is available—if too much straw does not go for paper-making—for increasing the output of farmyard manure, at the same time lessening requirements of imported manures. To that extent, with the call for the production of milk and vegetables and the necessity for close cropping, and with a broader view taken in framing a war-time diet, land more readily could be made to give of its best over a period by placing livestock feeding in the front line.

Production of beef and mutton, the backbone of our arable areas, has unfortunately become closely associated with imported feeding stuffs. The Prime Minister's injunction is "resolve to make the best use of expedients at hand"; but the use of home produce, as good hay, field beans, dried grass and linseed, has seemingly been lost sight of, thereby necessitating a larger supply of imported cake for use in dairying districts where, naturally, there is less cropping.

With an acreage under crop approaching that of 1918, against a loss of regular farm labour of 15,000, the position would appear beyond the energy, however willing, of farmer and available staff. Tractors and fine weather, as experienced in 1940, may do much to combat the shortage, but experiments have proved an ultimate loss in tonnage where sugar beet has been sown and worked too late. Similar results, though not always so directly brought home, are known to apply to all crops, so it becomes essential, if most is to be made of the greater acreage, that plans be laid to meet large labour requirements for summer and autumn work. Unskilled labour cannot meet the situation altogether.

Farmers are most willing to produce all that is possible, but, unfortunately, there is a dearth of capital within the industry, probably one of the most serious obstacles to progress, resulting in, as with labour shortage, a curtailment of farming operations with subsequent limitation of output. With the loss of capital has also gone confidence, confidence in himself to make good, and confidence in the industry. Capital and confidence may only return to the industry gradually through a price level commensurate with costs.

SIR GEORGE STAPLEDON, C.B.E., F.R.S.

Although as a war measure it may be necessary to concentrate on certain crops in particular, our efforts will fail unless we also concentrate upon the enrichment and husbanding of the fertility of the soil. Livestock must, therefore, be brought to play a full part in our plans. Two things would seem to me to be essential: firstly, in no circumstances to embark upon an exhausting rotation, and secondly, to give ourselves enough elbow-room. By giving ourselves enough elbow-room I mean the reclamation of land at present practically worthless (in terms of both large blocks of country and of single poor fields occurring, as they often do, as outliers on comparatively good farms) on a sufficiently large scale to match the heavy cropping necessary on kinder land. The two things are complementary in themselves, and also would go a long way to make it possible to maintain to the full our flocks and herds, as well as growing vast acreages of extra wheat, beans, potatoes, sugar-beet and other cash crops. There are large areas of seemingly very poor land, much of it—but by no manner of means all of it—at high elevations, which could immediately be made to grow crops like rape, hardy green turnips and Italian ryegrass, or good grass; while, incidentally, much bracken-land could be made to grow good crops of potatoes. By bringing in such land we should be immediately creating stock feed (and in a few cases human food) where before there was practically nothing, and also in our stride we should be making such land capable of carrying good cereal and other crops two or three years later.

This latter alleviation would help us to avoid the adoption of exhausting rotations on the better lands already broken, for it is so important that land that has been broken from grass, or from a pretence of grass, be put back into a good ley before the soil has been cropped out. My conviction always has been that we cannot attain to anything like the peak of production even on our better lands unless we spread wide the net of reclamation—for by spreading wide the net we can maintain our livestock and everywhere adopt sensible rotations. In this connection it must be remembered that the systems of farming best suited to one district are often dependent to a large degree on the systems adopted in another district—an interdependence which, if seriously upset, can only react against maximum production for the country as a whole.

A good example of this has been the poor prices obtainable for cull lambs and draft ewes from many hill flocks, because lowland farmers have gone too far towards cereals, without regrassing in their stride; a position that has been aggravated by the fact that there has been insufficient reclamation conducted on the higher and intermediate lands—lands which could easily have been made capable of sustaining the draft sheep and producing goodly acreages of oats as well. Indeed, it is not far short of the mark to say that the more livestock we can maintain in this island, by that much the more wheat, potatoes and other crops shall we be able to grow. Speaking quite broadly, meat means soil fertility: and if we are to have soil fertility, we must have sensible rotations and good leys. Good grass must be regarded as being an essential crop in the rotation, and that means, amongst other things, generous liming wherever lime is necessary. It is the ley more than any other single crop in the rotation that responds most sumptuously to lime, and in so responding, it leaves its further generous legacy of fertility for subsequent crops. There is a great deal of eminently reclaimable and potentially highly fertile land in this country, where the rotations should *begin* with the ley and not *end* with it: a great deal more where, at the first ploughing, cereal crop and ley should be sown together, and at the first intention. By adopting these means, we can plough up ever more and more of our worthless acres, and allow to every competent farmer the elbow-room that is so essential a factor in the attainment of high farming and maximum output.

W. ADAIR, Agricultural Editor, "The Glasgow Herald."

"How best can food production be increased?" is a question that was capable of more ready answer a year ago than it is to-day. In the interval the Government have taken many of the steps which practical farmers have urged towards this end. Whereas the 1940 cropping was entered upon without any definite knowledge

of prices in advance of the ploughing and sowing or planting, the 1941 cereal position has already been outlined, and while the potato position for that season has not yet been resolved in actual terms for growers, the settlement made for the 1940 main crop is pitched upon a scale that has undoubtedly spread confidence throughout arable farming.

"Confidence" is the word that requires to be emphasised, because it is a truism in farming operations, which must ever be subject to nature's cycle of husbandry, that "confidence is the best of all fertilisers." The Government appear fully to recognise that fact nowadays. In recent official pronouncements by Ministers there recurs the basic phrase that our farmers now have assured markets and guaranteed prices. In both cropping and dairying there is now substantial ground for confidence to "go to it."

Within recent months the position of meat producers has given rise for some misgivings. These misgivings have arisen because of the swing of the Government towards what might be called a directional policy of farming expansion. If these directional tendencies are to assure a definite increase in certain foods that the scientific advisers of the Government consider are essential to nutrition, without incurring a "decline" in other traditional forms of British farming enterprise, well and good. But the word "decline" has actually been used by the Prime Minister in his letter to the president of the English Farmers' Union, and this word has given the farming community some concern.

In the case of beef production, which is so closely linked with arable cropping, probably no harm has been done, though it is obviously clear that if the fertility of the land is to be maintained and increased we must return the straw in the form of dung. I am told that much land devoted to oats in 1940 offered plenty of evidence to show the increased yields that came from land that had been reasonably treated with farmyard manure, and the indifferent yields from land not so treated. In the quest for increased output of food we may achieve more tonnage from a *general increase of output per acre* of existing arable land than we could get from any reasonably practicable extension of tillage. Accordingly our main aim should be to raise output per acre generally.

How to make fuller use of our rough grazings, and how to restore confidence to our hill sheep farmers, appear to be the main problems at the moment. In farming policy we entered this war with perhaps a more definite assurance to our sheep producers than to any other class. On October 18th, 1939, the then Minister

of Agriculture, Sir Reginald Dorman-Smith, appealed for increased sheep production on the ground that our hill breeds, which form such a large proportion of our sheep stocks, are independent of imported feeding stuffs, and, as the latter were bound to be drastically cut, it seemed good policy to encourage sheep.

But the directional policy to which I have referred seems to cut across this intention. There is no question that our rough grazings, which cover such a large part of Scotland, are capable of much improvement. One of the most heartening signs to-day is the spirit of impatience and intolerance shown by our younger school of farmers against the persistent advance of bracken on our hill land. I have seen wonderfully good grass uncovered as soon as bracken was cut at the end of June. A real assault on this pest is overdue, and if there are many troops in the country next summer there ought to be some organised attempt to provide them with healthy exercise in tackling this botanical "fifth columnist," as Principal Paterson has described the bracken.

There seems plenty of scope to encourage market gardening, especially the production of onions, carrots and other vegetables that we formerly drew so heavily from Holland and the Channel Islands. Market gardening does not rely upon any imported materials, and expansion is wholly a matter of organisation. In bacon and eggs our Empire sources are responding. But so far as feeding resources permit we ought to enable home producers to do their part in filling the gap in supplies. We must recognise that our Northern European sources of egg supplies may be shut off for many years.

Finally, we must try to maintain our livestock numbers as fully as possible, in order that the ultimate source of all fertility, the dung-midden, is not neglected. A Polish farmer now in our midst talked sound sense when he told me the other day that the farmer who relies upon artificials is like the chef whose cooking requires a whole range of sauces and spices; the natural cook can provide appetising flavours without the sauces. In the same strain a leading Scottish market gardener once said: "I always lift my hat to the dung-midden." If we show similar respect in our campaign to increase food to-day, the land will amply repay us, and our action may prove the greatest investment of the war.

J. W. ALEXANDER, President, Blackface Sheep Breeders' Association.

I propose to deal with this subject as it affects the sheep farmer. I find it very difficult to do justice to the subject in the space allotted to me. It is generally admitted that hill sheep farms are not providing the quantity or quality that they did some

decades ago. The difference is not so great in the case of heather hills, but undoubtedly hill land on which white ground predominates is deteriorating seriously. This is quite easily understood, as the pasture on these hills is suffering from the continual drain of calcium and phosphates in the form of mutton and wool, and by grazing by one class of stock and nothing being returned to the land. The problem is how to improve the grazing economically. It is not possible under present circumstances to lime, slag or manure these hills. Other methods must be employed to do what is possible.

First.—Drains should be put in order—not all at one time, but by doing so much every year. In this way one can soon have and keep the drains in proper order. The cost is higher than it was, but is still not excessive, as the Government at present pays half of the cost.

Second.—The bracken should be cut. Again the Government helps with this necessary work when done by mechanical means. The rapid spread of bracken is making enormous areas useless for grazing purposes. The bracken also makes the shepherd's work much more difficult, and increases the loss from maggot fly, as the struck sheep hides in the bracken and is never seen.

Third.—Grazing with cattle. I agree with Sir John Milne Home when he advocates the grazing of cattle on suitable farms. The beneficial effects of this are indisputable. The cattle tear up the roughage and leave the finer grasses for the sheep. They also leave less cover for ticks. I know farms in my own district that have deteriorated since the practice of mowing the roughest parts for hay has been dropped. In advocating this grazing, I propose that it should be controlled grazing on the parts of the farm suitable for it. Control can be quite easily done now by electric fencing which can be moved as necessary.

Fourth.—Advantage should be taken of the means that the scientist has produced to control diseases by means of sera and vaccines. In this connection I think that the Government should encourage the use of these sera and vaccines by reducing the cost to the user. This would result in more extensive use of these remedies, especially on the smaller diseased farms. More lambs, and even ewes, would thus be saved to add to the farm production. Incidentally, the draining and bracken cutting will help to control disease.

I should here like to draw attention to the sheep tick and its serious and rapid spread throughout Scotland—a spread which is still unchecked. This insect, and the diseases which follow in its train, are a threat to sheep farming. Unless some means is found of controlling it, large areas of the country will have to be cleared

of sheep, as the result of the advance of the tick in many cases is to render the farm not worth farming.

Fifth.—Sheep farmers could do a good deal to improve conditions by breeding more for hardiness and good milking qualities. These points have been sadly neglected of late years. Breeders have been slavishly following fashionable show points in their sheep and buying rams showing these points, forgetting that very many of these rams and their mothers have never had to live on a bare hillside. I am glad to say that breeders have been looking more to the points I suggest at the sales in the last year or two.

Sixth.—A good deal more could be made of the marginal land on hill farms by ploughing up, liming, slagging and re-seeding or otherwise improving it. Every sheep farmer should, where-ever possible, grow on this land rape to feed off as many of his own lambs as possible. He will not regret this step, and if he takes advantage of all the Government subsidies, he will have greatly improved his pasture at little cost to himself.

Finally, in order to improve and even maintain production, the price for the produce must be sufficient to meet the farm outgoings and allow a reasonable allowance for the capital employed on the land, including rent or interest on the value of the land and permanent equipment. Under normal conditions the hill farmer may be expected to carry on and make his own fight for existence; but, while he is controlled in so many directions which increase his outgoings, arrangements must be made to secure that he will receive reasonable prices for his produce. He has not received such since war began.

JAMES CRUICKSHANK, **Cruden Bay, Aberdeenshire.**

At all times, but especially at present, it is very important that the maximum production should be got from the land, and there are various means by which considerable increases can be obtained.

Amongst the most important is good and timeous cultivation, with deep ploughing, which can now be done by tractors with excellent ploughs for the purpose. Where a farmer cannot manage this himself, it will often pay him to hire from one of the numerous contractors. There need be no gathering of weeds; they can be completely buried by the plough, or smothered by the crops. Early sowing, with a careful selection of the variety of grain suited for the particular soil, is most important, and it is also economic to get carefully-graded seed from a reliable source—for choice from an earlier district than your own.

Early sown grain is not so apt to lodge, and dressing with a mercurial compound effects a saving in seed. The yield of grain

can be greatly increased by an application of from 2 to 4 cwts. per acre high-grade superphosphates. If it is well mixed with the soil before the grain is sown, I have never known this fail to give an increase of from 10 per cent. to 30 per cent. in grain, or two or three times the value of the manure applied, and the crop will be appreciably earlier. Phosphates are specially valuable where old grass is being broken up. The farmer must judge for himself whether the crop will require an application of nitrogen, and this should not, in my opinion, be applied too early, and not at all where grass seeds are sown with the crop.

When the grain crop looks like lodging, this can be largely prevented by rolling with a heavy roller about the end of May, when the crop is 12 to 15 inches high. With this treatment it will look bad for a day or two, but it will come all right, and one invariably gets the desired result.

Soil analyses can be got free, and every farmer should take advantage of this privilege. It may not be possible, on account of labour or other difficulties, to apply all, or any, of the desirable lime and potash, but most farmers would be able to apply the phosphates.

Where the land is suitable, adding 12 to 15 lbs. peas to the oat seeding will increase the total yield of grain, and also the quantity and quality of the straw for fodder. Where the soil is heavy, one to two bushels field beans may be sown in the same way with a variety of oats such as Sandy, and again there will be a heavier yield of both grain and straw than with oats sown alone. This makes an excellent preparation for a wheat crop. In both cases, unless the grain is to be used for stock feeding, threshing had best be delayed until January, otherwise the peas and beans would be apt to mould when off the straw. The oats and beans ground together will make an excellent and valuable stock food.

Common bere is a crop which should be grown more widely. Sown with three bushels per acre, drilled in, it will readily yield 18 to 24 cwts. per acre. It is very responsive to phosphates and lime, and it is one of the best nurse crops for seeds, besides being an excellent feed for stock.

Similar treatment and manuring to that described has, over a number of years, on land in moderate condition, almost doubled the average yield of grain on a fairly large area.

Where wild white pastures are being broken up, it is often desirable to take a root crop first. For this an application of 6 to 8 cwts. superphosphates, or 12 cwts. slag per acre, will usually give a most profitable crop. Two useful grain crops may follow, seeds being sown with the second crop. If marrow-stem kale is sown as part of the root crop, 2 to 4 cwts. sulphate of ammonia,

sown along with the phosphates, may be profitably employed. With this treatment very heavy crops may readily be grown.

A great deal has been done in connection with the making of grass silage, and there is no doubt pasture production can be greatly increased by its use. The ordinary farmer would be safest to arrange for one cut only. Having selected the area he means to cut, it had better get a dressing of 10 cwts. slag per acre the previous autumn, or superphosphates and nitrogen from March to April. He should arrange to pasture his grass hard—up to the end of May or beginning of June, or even the end of June—according to his soil, and, having already got the early bite, he should then take one good cut when the grass is 15 inches to 18 inches high. There will then be an excellent pasture to follow for feeding off the cattle on the grass in autumn. On such a pasture cattle will do as well in September as in June. Making silage with grass, such as described, is simplicity itself, and provides a valuable food. It is no use trying to make good silage with what the stock will not eat in the fields! By varying the fields cut from year to year, a large area of pasture can be immensely improved.

J. B. DOUGLAS, Barstibly, Kirkcudbrightshire.

"How can food production be increased?" This question can best be answered by asking another—"Where and how has most food production been lost?" The consequences of the long depression show in all classes of land, but, broadly speaking, to a lesser degree on good arable and stock land, and to a greater degree on second and third-class land. The reasons are obvious and need not detain us.

Thus low ground stock, dairying and cropping farms are generally ready to play their full part in war production; indeed, with the longer leys of recent years, they have great reserves of fertility which can now be cashed to national and personal advantage.

The second and third-class arable and stock farms on higher altitudes, with a shorter grazing season, have suffered severely in capital reserves, in fertility and in equipment, and it is here that the best field for immediate action with the prospect of a reasonably quick return will be found.

Hill land, stocked mainly with sheep, is another and even more difficult problem, but one fact must be faced. The return from remedial measures, such as bracken cutting and draining, is sure, but it is too slow as a war measure, and should be undertaken as part of a war and post-war plan.

Attention should therefore be directed to land which used to produce moderately good crops, and which carried good breeding

stocks of cattle and sheep before it was allowed to tumble down to grass. It is a mistake to ignore this land because it may not produce a good crop in the first year—we must look to the succeeding crops, and, ultimately, to a good sole of grass. Besides, at the worst, even a very moderate crop is better for the nation than white, " buisty " grass, which will hardly carry a ewe and lamb to 3 acres.

With this class of land, re-seeding direct has points, but a rotation, including a cleaning crop, has more, for re-seeding a poor pasture is not quite as simple a business as it sounds in the lecture room, and when all's done, some of the bad grasses and weeds are still close at hand and may soon rise to dominance again, unless finally disposed of by a spring fallow, followed by a well-managed green crop.

In all this business, whatever the method followed, lime and phosphates are the keys to success, 30 cwts. of shell lime per acre on arable, or at least 20 cwts ground shell lime applied by manure distributor, preferably just before the green crop, but essentially some time before the land is laid down again. Phosphates are not easy to come by, but of those likely to be available, slag is the most suitable, and in this connection it is essential to remember that 10 cwts. per acre is more than twice as good as 5 cwts.

It is not easy to manage a green crop in these days of labour shortage, but with hired mechanical aid it should be possible to clean the land before it, so that in the end of the business, a complete re-seeding can be made.

Other times, other ways—the old rotations are too hidebound for the times. Under varying circumstances, consideration might be given some of the following variations :—

1. Catch cropping—*i.e.*, rye sown after an early harvest of the first oat crop, and used in the late spring following.
2. Ring the changes in the green crop break to reduce labour to a minimum, and choose from the following : kail, either in drills or broadcast, swedes, white turnips, rape and curly kail.
3. Grow mashlum or beans on any area which is suitable.
4. Grass ensilage, especially from hay aftermaths.
5. Improve meadows, and grow more and better hay. This is not spectacular, but is probably as fruitful a line as any.

In all this cropping programme there is a tendency to overlook pasture improvement, which is just as essential. The policy should be to plough the worst pastures first and start a round of manuring those which remain.

There remains the vital question of ways and means. Education and persuasion are too slow in their effect. The best stimulus

is a paying price for the products of this class of land. The objection that a price sufficient for this purpose is too good for the man on lower and better land is not serious, for, if his profits are unduly large, the Inland Revenue will take care of them.

Failing an adequate price stimulus, there remains only a further cheapening of lime and phosphates, coupled with some degree of control and supervision in really necessary cases. These will be few, for, if farmers have money, they are nearly always good to their land.

We must face the fact now that great areas of our secondary land are C.3. To remedy the situation, we need a definite impulse and a definite plan—a scheduled programme of progressive and rapid improvements. If this is to serve its purpose, it must be begun this winter, and before it is begun there must needs be assurance that the required quantity of lime and phosphates is available.

JOSEPH F. DUNCAN, Secretary, Scottish Farm Servants' Branch of the Transport and General Workers' Union.

The short answer which readily suggests itself is, increase the acreage under crop and increase the produce of crops and stock, but that leaves the problem of how to do so unanswered. The simple expedient of ordering every farmer to cultivate an extra percentage of his land saved a lot of worries to begin with, and had the appearance of meting out equal treatment to all, and for the first ten per cent. of increase created no great difficulty. But that was a rough-and-ready expedient which cannot be extended without raising questions whether the best use is being made of available resources. A more selective method in deciding what increase in acreage is to be sought becomes necessary, and several factors have to be considered by those responsible for the ploughing up campaign: the quality of the land: its suitability for the crops which are considered most necessary: the available equipment and labour supply, and so on. The test is not the addition to the area under cultivation, but the increase in the required production.

The scope for increasing the acreage under the plough in this country is so great that there is a risk that we may concentrate too much on that, and miss the opportunity for a greater increase in production from the land already under the plough. It is easier to order a man to plough up 10 acres than it is to induce him to take up the slack on 100 acres, but on a great many of the farms the possible increase from the area already under the plough would far exceed what could be got from the extra acres. The problem is how to apply the necessary stimulus. The idea that higher prices are all that is necessary does not hold. Easy money as

often leads to slackness as to extra effort. The appeal to public spirit is a spur when the spirit is there, but slackness is usually a sign that the spirit is not there. A tightening up of control will be necessary on a good many farms. Along with that there ought to go an extension of the advisory services to aid those who are willing but not so efficient, and for some credit facilities should be made more readily available. The aim is to get more production, and risks should be taken which would not in normal times be reckoned as sound finance.

If we are to secure an increased production of the crops and stock which we require, we must face the fact that more direction of farming is needed during war-time. Those in authority must decide what is wanted, and be prepared to give directions to have it produced. This is all the more necessary because we cannot rely on imported foods or feeding stuffs, on which our normal farming operations are based. We have to produce, and what may be as important, conserve, on emergency lines. No one engaged in the industry has any right to expect that he can follow customary routine. This year we had unusual luck at harvest time, but next year our luck may be out. If so, the labour problem may be serious, and a loss of produce ensue. We have control of agricultural labour—on paper, but we are in fact letting agricultural workers leak away. That ought not to occur. More attention will have to be given to making more efficient use of the labour available, and of making it more mobile when need arises.

WILLIAM GRAHAM, President, National Farmers' Union and Chamber of Agriculture of Scotland.

Under normal circumstances the simple answer would be "Provide the incentive to Speed the Plough," but the exigency of war introduces factors which make it necessary to depart from normal procedure.

It has become necessary to produce at home greater supplies of essential foodstuffs. To this end the Government have adopted a price policy designed to secure increased quantities of particular products, and a plough policy to accelerate a change from grassland to arable farming. For administrative purposes they have set up County Agricultural Executive Committees.

The increase of tillage in the first year of war is evidence of the good work done by these committees, and of the anxiety of producers to meet the national need. Plans for a second increase are now under way, but, in order to secure the concerted effort necessary for the full utilisation of our resources, there is an obvious need for a comprehensive production plan under which all branches of agriculture will be organised, and full use made of every acre of land, whether arable or pastoral.

To prepare and operate such a plan there would require to be close collaboration between the government departments concerned and those engaged in the industry. This would require the setting up of a representative committee to act in an advisory capacity to the Government; but it would be possible to dispense with certain existing committees of a sectional nature.

The problems created by the first year of the food campaign make it evident that, unless the efforts to solve these are co-ordinated, still further problems will arise which may be increasingly difficult to tackle.

The need for conserving our resources to meet the needs of a long war is obvious, and would seem to call for more intensive production on suitable land. To expend the available labour, manures, seeds and other requirements on indifferent land when more prolific land is available, must prove wasteful, but is difficult to avoid unless a more discriminating plough policy is evolved.

The feeding of livestock is necessary for the maintenance of soil fertility, and makes it essential to preserve the balance between feeding and breeding; undue displacement of stock by tillage and inappropriate seasonal livestock prices, coupled with the difficult feeding stuffs position, are factors likely to upset that balance.

Consideration must also be given to the effect of the price policy to ensure that production of unfavoured products is not retarded or stopped without a compensating increase in those preferred. Not all producers can change from one commodity to another. For example, our extensive upland pastoral lands, which are practically self-supporting in producing livestock, cannot turn to alternative commodities, and any reduction brought about there must mean a loss to the nation.

Milk supply, feeding stuffs allocation, regulation of marketing and utilisation of surpluses are some other problems requiring attention, which, with many others, are bound up in the general economy of the farms.

The need, therefore, for a complete survey of the position in the light of experience and all available information is apparent, if that confidence so necessary for maximum production of the nation's foodstuffs is to be secured.

Professor J. A. SCOTT WATSON, Oxford University.

It is not unnatural that food producers should be reluctant to make drastic changes in their well-established systems of farming, or that consumers should be averse to drastic changes in their food habits. Nevertheless we must face the fact that, if home food production is to approach the maximum, such changes are quite essential.

It is of course true that some increase in our food output may be achieved by better or more intensive farming upon normal pre-war lines. We may clear our ditches and mend our drains. We may lime our sour fields. We may increase our applications of such artificial fertilisers as are available in quantity. We may plough up our poor pastures and, by manuring and re-seeding, make good pastures in their place. We may make grass silage in place of part of our hay. We can increase efficiency and effect economies in many directions. But if we do only these things we shall be shutting our eyes to the most important of all the principles that bear on our problem. This principle is that we must cut down those forms of production that give us small outputs of costly foods, and expand those other forms that give as large outputs of cheaper but no less nutritious food.

If we cease to think in terms of money and calculate outputs in terms of nutritive values, we arrive very quickly at certain clear-cut contrasts between the different possible ways of using land. The main facts, expressed in round figures, are these :—

1. Average farm land, growing arable fodder crops such as roots and oats, yields about twice as much stock food as similar land producing meadow hay.

2. The conversion of any vegetable product into meat involves a very large loss of food values. The loss varies from rather more than eighty per cent. at the best, to about ninety per cent. at the worst.

3. The food output of average land, lying in grass and producing beef and mutton, will be increased from ten to twenty fold if it is converted to arable, and used for the production of food crops—potatoes, wheat and vegetables.

4. The efficiency of the dairy cow, as a converter of grass and other fodder crops into human food, is more than three times as high as that of the beef animal or the sheep. This calculation takes no account of the difference between milk and meat as "protective" or "health" foods. In this respect milk is incomparably the better food.

5. Potatoes, sugar beet and certain vegetables yield about twice as much human food, per acre, as grain crops.

It seems clear that the most effective measure open to us, in the way of increased food production, would be deliberately to reduce our output of beef and mutton in order to provide for the expansion of our acreages of potatoes, vegetables and grain. So long as our ploughed-up acres are used mainly to produce substitutes for imported feeding stuffs, our gain in food output will remain small; it can become substantial only if we use these acres for crops that are, or can be in an emergency, consumed by human beings. How far we could carry the process, and how fast

we could proceed, would require careful working out. It may, however, be noted that the total acreage of the main food crops (including oats, barley and sugar beet, as well as potatoes and wheat) fell from 10·9 million acres in 1874 to 6·1 million in 1939. Concurrently, our head of cattle rose from 6·1 to 8·1 million.

So long as milk production can be maintained, this suggested change in our agricultural output need have no ill results on the well-being of consumers. The effect would be to give us a diet approaching that of the average French citizen in ordinary times—a diet containing more bread, potatoes, vegetables and milk, but substantially less meat than we have been accustomed to eat. This type of diet has been imposed on France by conditions not unlike those with which we are now confronted—a lack of manufactured exports, and a consequent lack of means to pay for imported food. The comparison of the pre-war dietaries of the two countries is as follows:—

AVERAGE CONSUMPTION—POUNDS PER HEAD PER ANNUM, 1934-1938.[1]

	Great Britain.	France.
Potatoes	197	280
Cereal flour	210	400
Sugar	109	56
Meat, including bacon	143	74
Milk	200	230
Butter	22	13·3
Cheese	9·5	12·5

The French diet is cheap, as ours must now become. It is much more largely home-produced, as ours must now be. But it is by no means poorer, from the nutritional point of view, than our own.

T. A. WEDDERSPOON, Eassie, Angus.

Mr Churchill has said: "We have to think of the years 1943 and 1944, and the tonnage programmes we shall be able to move, and have to move, across the seas then. Every endeavour must be made to use the time available to produce the greatest volume of food of which this fertile island is capable."

Four words stand out: "time available" and "greatest volume." In this war for our very existence British agriculture must work to its utmost capacity. It will be necessary, as in other essential industries, to call upon reserves. The stored up fertility

[1] No accurate statistics of vegetable consumption are available. The French consumption, however, is undoubtedly the higher.

of many thousands of acres of grassland must be released when it is most needed. This can only be done by ploughing. Arable land will always feed more people per acre than grassland. One hundred acres of potatoes will produce enough food to maintain 420 persons for a year. The same acreage of wheat will maintain 230 persons, barley 180, oats 155. One hundred acres of potatoes fed to pigs will produce food for 90 persons. One hundred acres of average grassland producing beef and mutton will maintain only 10 to 15 persons.

As in 1917 the submarine menace is threatening our country with blockade. It may well be that the efforts made by British agriculture will prove one of the decisive factors towards victory. There are several factors which place us in a more favourable position than that of 1917:—

1. The arable farmer of to-day is producing much more off an acre than he was 20 years ago.

2. Mechanisation has made tremendous headway, and is to-day the sole means of increasing cultivation and maintaining that increase.

3. The wider powers of the Agricultural Executive Committee, if wisely but firmly used, can do so much.

4. The Sugar Beet Industry, so wrongfully and so much maligned by short-sighted people in the past ten years, is now thoroughly established.

On the other side of the picture the effects of the recent depression in British agriculture are all too obvious. Apart from many thousands of acres of so-called grassland, sown down anyhow, the most serious factor is wet land. Many years of neglect cannot be overcome in one, or even five, years, but much can be done, and in the majority of cases will have to be done by the Agricultural Committees. The cleaning of ditches and streams, and tile drainage on the land most seriously affected, should be undertaken at once. County Council roadmen, who are not now fully employed on road maintenance, and unemployed miners, could be made available for this work. The permanent employment of drainage gangs, under proper supervision, would also ease the labour shortage at peak periods such as harvest, when each gang could assist in its own area. In Scotland prompt action will soon need to be taken to see that adequate supplies of drain tiles are available in each area.

If the fertility of the land is to be maintained, all the straw from the increased tillage must be made into farmyard manure. Many more acres of root crops must be grown than at present. We must revert to the basic system of farming which built up the fertility of these islands—the system followed by our forefathers. With less imported feeding stuffs available it will be necessary to

keep our cattle and sheep for a longer period with no forcing. To do this, many derelict buildings may require to be brought back into commission by patching up, at any rate upon a temporary basis.

The Land Fertility Scheme has done much to bring lime to sour soil. The lime should be applied to the land most in need of it. This can be satisfactorily ascertained only by soil analysis. Much good work could be done here by chemistry students of 16 or 17, under proper supervision.

For many years progressive arable farmers have treated their seed grain with a mercurial dressing, and, in addition, dressed the seed through a seed cleaning plant. Results justify this, and steps should be taken to see that it becomes universal practice.

The demand for certified stocks of Scottish seed potatoes is greater than the supply. It would appear wise in the national interest to permit the maximum quantity of seed-sized potatoes to go to England, and for Scotland to plant ware from certified stocks. It will surely be tragic if a great part of these stocks are fed to cattle and pigs as part of the surplus which would inevitably be left in the main potato producing areas.

The advantages of mechanisation can be further extended by a more general use of the " shift " system during the hours of long daylight. A sixteen-hour day is possible for tractor and implements for many weeks of the year. The results are much more satisfactory than those from one man working for 10 to 11 hours day after day.

SCOTTISH AGRICULTURE IN WAR-TIME.

THE outbreak of war on 3rd September, 1939, was an event of the greatest significance to agriculture. From the very beginning steps were taken to assume control of the industry. In an effort to defeat the enemy and achieve final victory machinery was put in motion to mobilise and organise the whole of our agricultural resources. The full implications of that step cannot even now be fully realised or foreseen.

Lessons of the Last War.—Experiences of the war of 1914 to 1918 had taught us many lessons. They had shown us, amongst other things, that, because of our insular position and of our great dependence on imported foods and feeding-stuffs, it was imperative in time of emergency that every step should be taken not only to safeguard the continuance of supplies of food, but also to make good any deficiency that might occur as a result either of enemy action or of deliberate policy.

They had also shown us that satisfactory results could only be obtained if adequate steps were taken to organise, direct and control agricultural production. Not until that was done, and not until definite objectives were outlined, could the farming community take its place effectively alongside that of the fighting forces in the country's first line of defence.

Scottish Agriculture in 1939.—The picture presented by Scottish agriculture at the outbreak of war was rather a sombre one. Between 1918 and 1939 the area under tillage had fallen from 2,099,000 to 1,480,000 acres. The drift towards grassland, so pronounced a feature of agricultural system during the closing years of the last and the opening ones of the present century, had, shortly after the declaration of peace in 1919, been resumed with accelerated speed. Despite subsidies, deficiency payments, grants of various descriptions, marketing boards, intensified education and research, etc., there had been a steady decline in the tillage acreage and an increase in the amount of grassland,

Unfortunately the increase in grassland did not balance the loss in tillage. Many of the acres lost to tillage were lost permanently to agriculture. The yearly toll exacted by city, town and county house-building and road-improvement schemes, by aerodromes, by sports clubs, etc., was a formidable one. Much of our most fertile land was irretrievably gone. The nation as a whole had seemingly no more interest in the land. Not only the great increase in the matter of food production achieved in the years of war, but much more, was lost in the years of peace.

War-Time Policy.—Fortunately the whole of the lessons learned during the last war were not forgotten. Realising the vital importance of attaining a greater degree of self-sufficiency in the

matter of both foods and feeding-stuffs, and thereby releasing both foreign credits and shipping for the all-important purpose of the purchase and conveyance of war materials, the Government decided that, in the case of an emergency arising, immediate steps should be taken to win back to tillage such lost acres as could be obtained, and to direct general agricultural production in such a way as to safeguard both the energy and the health of our nation.

Committees—Their Powers and Functions.—In that year or two before the war, when threatening clouds began to drift across the international horizon, plans had been drawn up with these ends in view. Scotland was divided into forty areas—counties, parts of counties or combined counties —each of which was to be administered, so far as food production was concerned, by an Agricultural Executive Committee. On 4th September, the day following the outbreak of war, these Committees were called into being by the Secretary of State for Scotland. To them were delegated, in terms of the Cultivation of Lands (Scotland) Order, 1939, certain powers under the Defence Regulations, 1939. These powers gave authority to Committees to enter upon and survey land, to issue directions as to the cultivation, management and use of land, and in certain circumstances to manage land of which possession was taken. The Committees were also asked to give attention to all matters incidental to increased cultivation. It thus became their task to review such problems as the supply and distribution of fertilisers, feeding-stuffs, agricultural implements and accessories; to deal with certain labour problems; to conserve the interests of livestock, so far as was consistent with the tillage programme, and to apply measures for the destruction of agricultural pests. The immediate programme of increased tillage was to win back some 260,000 acres for the harvest of 1940.

Justification for Plough Policy.—It is advisable at this point to explain why increased cultivation was so closely linked with increased production and self-sufficiency in the matter of foods and feeding-stuffs. A considerable amount of misapprehension existed, and still exists to some extent, on this point. The conversion of grassland to tillage merely meant—so it was argued—a change from one kind of food production to another, and the question that naturally followed was, "Is anything to be gained by this policy?" It was contended, for instance, that, under many circumstances, so far from any gains being achieved, considerable losses would be incurred by the breaking up of our pastures.

The point that objectors to the plough policy failed to grasp was that crops consumed directly by human beings yielded far more food than crops like grass, which could be converted into

human food only by animals. To cite an extreme instance it may be stated that the average crop of potatoes, most of which can be consumed directly by human beings, is reckoned to be capable of maintaining (*i.e.*, providing with a sufficient supply of energy) over forty times the number of people maintained by the same acreage of average grassland devoted to meat production. The efficiency of the different crops in this respect varies according to the crop and to the proportion that can be consumed by human beings. Thus cereal crops, which produce both straw and grain, and of which less than half is edible by human beings, give half or less than half the maintenance figure yielded by potatoes.

Another variation is due to the efficiency of the various animals in converting feeding-stuffs of one kind or another into human foods. In this respect, the cow producing milk is more efficient than the fattening animal producing beef. Similarly, pigs are more efficient in converting grain, offals, etc., than either sheep or cattle (it should, however, be noted in passing that pigs can deal only with limited quantities of bulky food). It is reckoned that 100 acres of average pasture devoted to either beef or mutton production can maintain only nine persons for a year, whereas such an area devoted to milk production could maintain about forty persons. The same acreage devoted to the growing of average crops of oats, wheat and potatoes is capable of maintaining about 170, 210, and 420 persons respectively.

Considered in this light, there seems to be an unanswerable case for an increase of tillage in time of war. But other aspects of the situation had to be considered. There was, for instance, the very important aspect of maintenance of health. From this point of view, an all-cereal or an all-potato diet could not, of course, be considered as suitable. The comparisons given above are applicable only when the phrase "provided the foods are suitably mixed" is read with them. Food experts were of opinion, however, that, provided ample supplies of milk, fats and vegetables were at all times available, along with abundance of cereals and potatoes, neither malnutrition nor starvation need be feared. Some, indeed, went so far as to say that, provided the dietary habits of the people were regulated according to the rationing principles adopted by dairy farmers in feeding their cows, and provided also proper steps were taken to ensure that the foods mentioned above were each grown in sufficient quantity to enable this rationing to be done, no special difficulty would stand in the way of making our country self-supporting in the matter of food.

Another matter that had a pronounced bearing on the Government's agricultural policy was the necessity of maintaining the fertility of the land. It was affirmed that, unless our live-stock was maintained in sufficient numbers, crop yields would

inevitably suffer. On the other hand a new school of thought had arisen which pointed out that fertility could be promoted by the increased use of the plough as a preliminary measure in breaking up our second and third-rate pastures. Thus, it was contended, by creating new and improved pastures our livestock numbers could be maintained on smaller areas, while far more use could be made of the fertilising properties of wild white clover, the legume most suited to Scottish conditions.

It was obvious too that, whatever policy might be adopted, serious reductions in the numbers of such livestock as sheep and cattle should not at first be contemplated. These animals fulfilled the very useful function of converting bulky foods such as grass, straw, turnips, etc., into products edible by human beings. Our rough grazings could only be utilised for food production by means of these animals. Besides all this, as has already been pointed out, ample supplies of milk were absolutely essential for the national well-being. Milk is essentially a "health" food. The consideration of how milk supplies could be maintained or even increased in time of war brings us to still another point, the relationship of milk production to imports of feeding-stuffs.

Before the present war, the supply of milk in winter had depended largely on supplies of imported feeding-stuffs. Since the end of the last war dairy farmers had made increasing use of these. Many, indeed, so far as the production of winter milk was concerned, had come to regard home-grown foods as merely providing the maintenance rations, the production rations consisting very largely of imported foods. Obviously, if the output of winter milk was to be maintained, it was necessary to ensure that any shortage of feeding-stuffs occasioned by the war would be made good either by increased supplies of home-grown concentrates like oats, beans, etc., or by providing cows with such home-grown foods as high-quality silage, which required but little concentrates to enable a well-balanced ration to be made up. Lack of appreciation of the above points was largely responsible for the serious drop in our milk output in the last war. This drop was related but little to a shortage of pasture; it was most pronounced in the winter months.

In determining the general policy to be followed consideration had, therefore, to be given to adjusting all the above factors—the necessity for cutting down our imports of foods and feeding-stuffs, the need for maintaining our milk supplies, particularly in winter, the making of the fullest use of our land without impairing its fertility, and the desirability of ensuring that any adjustments that might be made were both possible and practicable. In asking Committees for some 260,000 acres additional of tillage for the harvest of 1940, it was felt that only small reductions in the

numbers of livestock need be occasioned, that the milk supply could be maintained, and that the output of both beef and mutton would be but little diminished. How far these expectations were realised will be discussed later.

Ploughing Grant Scheme.— Before proceeding to consider how the Committees carried out their allotted tasks, it seems desirable to mention that part of their work, viz., the increase of the tillage area, had already been in some degree anticipated by the operations of the Ploughing Grant Scheme, instituted in May, 1939, with the two-fold object of (*a*) bringing more land under tillage for the harvest of 1940, and (*b*) breaking up poor pastures for the purpose of either immediate or ultimate improvement. This scheme, which applied to grassland seven years old or more, had, by the outbreak of war, induced farmers to take steps to plough up a certain amount of additional land. Originally the closing date for the ploughing to be finished was 31st October, 1939. After the outbreak of war the scheme was directed towards giving an increased acreage of tillage cropping, the closing date was extended to 31st December, and the Committees were asked to deal with applications received after 4th September. Re-seeding, with or without a nurse crop, could still be sanctioned, but the Committees as a rule recommended this only in rather exceptional circumstances. The attraction of the grant of £2 per acre had a marked effect in easing the work of the Committees and their visiting members. Farmers, realising that, both in their own and in the national interest, more old grassland should be broken up, were willing and eager to take what advantage they could of the scheme. The closing date was further extended to 31st March, and later, on account of weather conditions, to 30th April, 1940.

Committees' Officers and Organisation.—So keen were the Committees to get to work that many of them held their first meetings within a few days of their appointment. Their first and most important task was to survey the farms within their areas with a view to determining what additional tillage, if any, could reasonably be required. For this purpose, in most cases, district or parish sub-committees were appointed, including co-opted members chosen for their local knowledge. Sub-committees were also appointed by most of the Committees to deal with such matters as cultivation, feeding-stuffs and labour, and with questions specially affecting certain areas, such as deer in the Highlands and horticulture in Lanarkshire. Recruiting for the Women's Land Army was dealt with by women appointed to take charge of this special kind of labour.

The Secretaries of the Committees were usually local men of business, but in some cases officers of the Agricultural Colleges

undertook the secretarial work. Each Committee had an Executive Officer also, usually the County Organiser for Agricultural Education, to advise on technical matters and to assist generally in its work. In certain of the smaller Committees the offices of Secretary and Executive Officer were combined. Technical Officers of the Department were appointed to act as Liaison Officers, in order to ensure efficient co-operation between the Committees and the Department, while the services of the Department's surveyors were made available for the measuring and recording of the areas of grassland ploughed up, and for the guidance of the Committees on technical matters relating to drainage, fencing, building, etc.

The Department supplied each Committee with a quota figure for increased tillage within its area. The Committees were also furnished with tables showing the changes in their areas in the acreages of crops and grass between 1918 and 1937; with lists of the agricultural holdings within their areas; with summaries of the agricultural returns made on 4th June, 1939, in respect of holdings over five acres, accompanied in each case by a report form on which particulars relating to the holding could be reported; and with the appropriate sheets of the 6-inch Ordnance Survey map, together with the sheets of the 25-inch map, so far as these were available.

Survey of Farms.—The work of the Committees was somewhat delayed at first by the preoccupation of all arable farmers with the securing of their grain harvest. As soon as that was over the farm survey work was begun in real earnest. The task of visiting each farm, of determining in consultation with the farmer what land could most suitably be ploughed, of recording on the 6-inch maps the grassland ploughed up under the grant scheme, and of furnishing the Committees with full information regarding the working of the farm, was by no means an easy one. Nevertheless, visiting members generally carried out their work both quickly and thoroughly. Their reports were considered first by the district sub-committees and then by the main Committees, who referred cases of doubt back to the sub-committees.

General Response.—The response to the call for increased cultivation, though promising on the whole, was soon seen to vary considerably according to the area and the style of farming practised. Farmers everywhere were imbued with the patriotic spirit, and were willing to do what they could towards furthering the tillage campaign, but various practical difficulties had to be faced, and it was soon realised that quotas for particular farms or areas might not be forthcoming. Thus the labour situation after the outbreak of war was not merely difficult at the time, but also uncertain as to the future. In the later and poorer districts,

much of the higher and less productive land had, for economic reasons, been laid down entirely to grass before the outbreak of the war, and many farmers on such land had no equipment for breaking it up. The depression in agriculture, which had been so pronounced a feature of the previous ten years, had been felt most in the oat-growing and stock-rearing areas, and farmers in these districts naturally felt that they should be assured of remunerative prices before being asked to embark on a policy that might involve them in financial loss. A number of farmers, again, who were quite willing to plough up land, were handicapped by the lack of the necessary capital. Moreover, by the time the survey was being made, the low-ground flocks of sheep, which to a large extent were grazing land laid down to grass since the previous war, had either been mated or were in process of being mated, and farmers found it difficult there and then to make the required adjustments in their stocking to enable land to be ploughed. These and many other difficulties were encountered by members of visiting committees. Broadly speaking, particular difficulties were related to areas where farming methods were somewhat similar. It will be convenient, therefore, to consider the response area by area.

Eastern Arable Area.—In Angus, Perth, Fife, Kinross and the Lothians the traditional system of farming is based largely on the production of cash crops, such as cereals and potatoes, along with the fattening of both sheep and cattle. In all these counties there had, however, in the pre-war years been a persistent decline in the tillage area due to the returns from the poorer land failing to meet the costs of production. Such land had largely been laid down to permanent pasture. Thus, while the acreage of tillage had declined by a fourth, the acreage of permanent pasture had increased by a fourth. This increased acreage of grassland was grazed mainly by sheep.

In this group area the response to the increased tillage campaign was highly satisfactory. Much of the land laid down to permanent pasture could qualify for the grant of £2 per acre. Tractors were abundant throughout the whole area, and in no district could the labour situation be described as acute. As soon as it became generally recognised that wheat, oats and potatoes were likely to sell at remunerative prices, farmers responded well to the requests of visiting members for increased cultivation. Almost the whole of the 53,000 acres asked for were actually obtained, and this despite a certain acreage being lost to agriculture through land being required for the fighting services.

Border Area.—In the four border counties, Berwick, Roxburgh, Peebles and Selkirk, sheep occupy a most important place in the general economy of the farm. At the lower elevations

very large numbers of low-ground breeds of sheep are almost universally carried; higher up, where the low ground merges with the hill proper, the breeds kept are Cheviot or Blackface. In these areas a great deal of land, particularly in the lower parts, besides being eligible for the £2 per acre grant, was suitable for cropping. Difficulties connected with the adjustments of the sheep stock in the first year had, however, to be faced. The result was in keeping with expectations. Berwick obtained a high proportion of its quota, but in the area as a whole the proportion was considerably below that achieved in the eastern arable area. This was due mainly to difficulties connected with the ploughing up of the higher lands.

South-Western Area.—In this area, which may be taken as extending from the Solway to Stirling (including Clackmannan) and Dumbarton, the system of farming is largely associated with dairying. Partly because of this, and partly because the climate favours grass rather than tillage, the percentage of tillage land is normally much lower than in the eastern area. The pre-war years had also seen a very considerable increase in both the acreage and the proportion of land under permanent grass. Thus, while in 1918 the tillage area was approximately one-third of the total area under crops and grass, by 1939 it had declined to about one-fifth. This decrease was reflected in a very large increase in the area of permanent pasture, in a considerable increase in the number of cattle, principally dairy cattle, and in a slight increase in the number of sheep. There had been an increasing tendency on the part of dairy farmers in this area to utilise their farms mainly for grass and hay production, and to rely on the purchase of concentrates, chiefly from overseas, for maintaining their winter output of milk at the desired levels The requirements of the Committees met with a ready and willing response. In face of an expected shortage of concentrated foods, farmers were easily persuaded to break up land for the purpose of growing such crops as oats, mashlum and beans, thereby reducing their dependence on purchased feeding-stuffs. Particularly was this the case when there was ample scope for earning the ploughing grant, and where serious adjustments of low-ground flocks of sheep were not required. Shortage of grazing in the following summer could, it was felt, be made good partly by taking up the "slack," so to speak, and partly by manuring the remaining grass. The net result was that a very large proportion of the desired acreage was brought under the plough.

North-Eastern Area.—Less satisfactory results were obtained in the north-eastern area, embracing the coastal counties from Nairn to Kincardine. Here the system of farming practised is that of stock-rearing and fattening of both sheep and cattle, com-

bined with the growing of cereal crops and roots. The area had been adversely affected by the comparatively low prices ruling for oats, beef cattle of high quality, and sheep. As a result, much of the poorer land had gone entirely out of cultivation, while farmers in the better areas had sought to reduce their working expenses by widening their rotation in favour of grass. This policy enabled them, besides reducing expenses, to take fuller advantage of the better grazing and the increased fertility of the soil resulting from the inclusion of wild white clover in the grass-seed mixtures. The extra grazing thus created was largely utilised for low-ground flocks of sheep, principally ewes. The number of sheep in one Committee's area had actually trebled since the close of the last war. The difficulty of immediately adjusting these ewe stocks, shortage of labour owing to a considerable number of the farm servants having been in the Territorial Force at the outbreak of war, combined with a background of poor years, unremunerative prices for oats and a late harvest, militated against the breaking up of the younger rotation grasses. Moreover the ploughing grant provided farmers in this area with but little inducement to break up additional land. The area laid down to pasture that could qualify for the grant was comparatively small, and much of it consisted of infertile land incapable of yielding remunerative crops. The net result in this area was in consequence somewhat disappointing.

Northern Area.—The agriculture of the counties Inverness, Ross, Sutherland and Caithness resembles, so far as the arable land is concerned, that of the north-eastern area. In these counties, however, the farming of the arable land is closely linked with the hill sheep farms. The arable farmer buys the hill farmer's surplus stock, provides wintering for the ewe lambs off the hill, and in many instances combines his arable activities with those of sheep-farming. Again, a large proportion of the arable land lies at a higher elevation than in the north-east. In view of poor prices ruling for oats, fat cattle, fat and store sheep and wool, the prospects of increasing the tillage percentage in this area were certainly none too bright. There were also difficulties connected with stock adjustments and labour. Many of the Territorials who had been called up had been farm servants, while many more farm servants, attracted by the higher wages paid by contractors engaged on Government work, had previously left the farms. In Orkney the labour situation was indeed acute, no male labour being left on some of the smaller farms. In the northern mainland counties many of the higher and poorer arable lands, formerly worked in regular rotation, had gone down entirely to grass. Although such land might qualify for the £2 per acre grant, farmers were reluctant to break it up, in view of the doubt

as to whether the crops would ripen, the difficulty of harvesting them and the prospect of low yields. Here again the response to the ploughing campaign was disappointing. In Orkney, however, despite the labour difficulties referred to above, and the fact that large areas of agricultural land had been taken over for defence purposes, the results were relatively better.

Other Districts.—The remainder of the country may be dealt with in a few sentences Bute, Arran and Kintyre gave results not unlike those of the south-western counties. In the north mainland of Argyll, and in the islands comprised in that county and in Inverness, Ross and Zetland, the results were poor Many of the crofts and farms had gone down entirely to grass. There were neither men nor horses and implements left to cultivate the land.

Effect of Season.—While the latter months of 1939 were unusually mild and open, a different state of weather conditions had later to be faced From the closing days of 1939 right up to the beginning of March, 1940, and in certain areas until almost the end of that month, practically no ploughing could be done, exceptionally hard frost prevailing everywhere The winter was the coldest experienced for almost fifty years The result was that at the beginning of March most of the ley, a considerable proportion of stubble land, and all the red land had to be ploughed. Fortunately, once ploughing became possible it went on almost without interruption, and by the end of April most of the cereal crop had been sown in a good seed-bed. The normal work of seventeen weeks had been crowded into a period of seven to nine, according to the district The success attending these spring operations was undoubtedly due to the widespread use of tractors, the numbers of which had, in recent years, increased very considerably in many areas throughout Scotland In many cases these were used continuously throughout the day, relief drivers being employed to take the place of the regular drivers at meal-times and in the evenings Remarkable evidence of rapid work was forthcoming, one Kincardineshire farmer ploughing over forty acres of ley and stubble in a week with an ordinary two-furrow tractor plough

In carrying out this work farmers in many instances made the fullest use of substitute labour. Young lads and Land Army girls, who were employed as relief drivers, soon showed that they were capable of doing very good work The prejudice of many farmers against any form of substitute labour was being broken down, often by the very girls on whom ridicule had been poured.

Government's Tractor Reserve.—In order to ensure that any farmer, who might experience difficulty in carrying out the necessary cultivation connected with increasing his tillage area, could carry out his work effectively, a Government reserve of

tractors and equipment was created. It was intended that this reserve should be called upon only after it was found impossible for the farmer's own staff or local contractors to carry out the work. In order to obtain the services of these tractors, etc., farmers who found themselves in difficulties as regards cultivations, were asked to approach their local Agricultural Executive Committees. When these were satisfied that all local means of carrying out the work had been exhausted, steps were taken to get the work done by the Department's Tractor Section In the crowded weeks of March and April the fullest use was made of this service, and well over 12,000 acres of land were ploughed.

Agricultural Labour.—It has already been noted that at the outbreak of war the labour situation was somewhat difficult. For some years before the war there had been a scarcity of farm labour in certain areas. This difficulty had been aggravated by the mobilisation of the Territorial Force, and although agricultural workers over the age of 21 had been placed in the schedule of reserved occupations, farmers had to face the ever-recurring calling up of the 20 to 21 age group. Naturally this gave rise to doubts as to their ability to undertake the laying down and harvesting of an increased acreage of crop. To meet the immediate difficulties consequent on mobilisation, the military authorities permitted the employment of a certain amount of soldier labour for the 1939 grain and potato harvest. This, in itself, proved to be a great boon to farmers in certain of the northern areas where the harvest was both difficult and protracted. A certain limited number of Territorial officers and men of the managerial class were also given indefinite release, while others were afforded short periods of absence throughout the winter to assist in the work of the farm. Postponements for limited periods of the calling up of the 20 to 21 group were also permitted. In all these measures advice was sought from the Committees.

There were, however, misgivings as to the future. Farmers naturally pointed out that an extension of the tillage acreage was scarcely consistent with the policy of cutting off of the main source of the labour supply. With a view to affording help in other directions, the possibilities of providing substitute labour were explored, and from time to time certain practical measures were taken. Thus, even before the outbreak of war, preparations were made for recruiting and training women willing to work on the land. Before September was out, the recruits to the Women's Land Army, as this body was called, numbered over 1000. Most of these were given a month's preliminary training at Auchincruive, near Ayr, or at Craibstone, near Aberdeen, under the West and North of Scotland Colleges of Agriculture respectively. At

these centres the recruits were taught, amongst other things, to handle tractors, to milk cows and to manage livestock. Another measure immediately taken to secure the 1939 potato harvest was the easing of restrictions on the employment of children of school age. Thus, in Angus, potato holidays were allowed, not merely for children attending country schools, but also for those attending certain burgh schools. In the course of the winter 1939-40, thanks to the help afforded by the Women's Land Army, to a certain drift back to agriculture of workers formerly engaged on farm work, and to adjustments effected at the Martinmas term, the situation became somewhat easier. By the beginning of May, when most of the cereal crop had been laid down, farm work was practically up to, and by June it was distinctly ahead of, schedule time. Increased mechanisation on farms had shown that, so far as the preparation of the land for the laying down of crops was concerned, the farm tractor was a great labour-saving device.

Pasture Adjustments.—As has alreadv been stated, it was expected that the results of the first year's tillage campaign would have but little effect on the numbers of livestock. The experiences of the last war had shown definitely that the reduction then effected in the grassland acreage as a result of the ploughing campaign did not, at first at any rate, have any pronounced effect in reducing the numbers of livestock. At the outbreak of war the number of stock grazed on farms was frequently below the grazing capacity of the farm. Although this policy of providing an over-abundance of pasture might be justified as an insurance against a bad grass season, it was also the outcome of the recently increased acreage of grassland and of the increased productivity of the wild white clover pastures, farmers finding it difficult to adjust the summer stocking of their farms in relation to the winter. A certain amount of "slack" could thus be taken up. Furthermore, increased productivity of grassland was possible in two directions, (*a*) by making increased use of quick-acting manures on the better class pastures, and (*b*) by ploughing up, manuring and re-seeding the poorer. Besides all this there existed in Scotland a vast and largely unexploited reserve of pasture in the shape of deer forests, unstocked grouse moors, golf courses and sporting land of one sort or another. Although much of the deer forest land was worthless for grazing, it was felt that considerable use might be made of the better areas for grazing stock displaced, either directly or indirectly, by the ploughing campaign. Agricultural Executive Committees in the deer forest areas did their best to induce owners to make these deer forests available for grazing. In most cases the numbers of deer were reduced, and arrangements made for stocking the forests. In cases

where the owner was either unable to graze the land himself or to get a tenant to do so, the Committees tried to find suitable tenants. Unfortunately the results obtained were very disappointing, and the total numbers of extra stock grazed on deer forest land were far short of expectations. The main causes for this were (*a*) the depressed state of the hill sheep industry, (*b*) a general scarcity of suitable breeds of cattle for such grazings, (*c*) the general lack of equipment on deer forests, e.g. cottages, bughts, dippers, fences, etc., (*d*) hesitation on the part of farmers to stock deer forests because of probable losses due to straying, drowning, etc., and (*e*) the fact that low-ground grass, in spite of the ploughing campaign, was plentiful.

Feeding-Stuffs.—For the first two or three months of the war no particular anxiety was felt by Committees regarding the feeding-stuffs position. Most compounders and distributors of feeding-stuffs, and many farmers, had laid in large stocks prior to the outbreak of war. In November, 1939, a public announcement was made to the effect that the shortage of shipping caused by war conditions would necessitate a certain curtailment of imports. Pig and poultry keepers were asked to plan their programme for the coming year on the assumption that the proportion of their purchases derived from imports would be reduced by at least one-third.[1] Farmers who specialised in milk production were, however, assured that every effort would be made to release sufficient supplies to maintain milk production at the customary levels. For fattening cattle and sheep the supply of oil-cakes, etc., for the remainder of the winter was expected to be slightly shorter. To meet the Government's wishes that as equitable a distribution as possible should be effected, distributors submitted their regular customers to a rationing scheme based on their pre-war purchases.

To provide for an emergency, reserves were created at various centres. These reserves were earmarked for breeding stock that could not otherwise be given sufficient food. Release orders were generally given on the recommendation of the appropriate Executive Committee. These emergency reserves were fully taken advantage of in certain areas, principally in the north-east, where the hard winter had virtually destroyed what remained of a rather poor crop of turnips, and where, in consequence, roots for lambing ewes were unavailable.

As a result of these measures individual cases of hardship were exceptional. The main complaints made during the winter related to difficulties experienced in getting sufficient supplies of "straights," particularly barley and maize and certain cakes, and in

[1] A further Press notice announcing the probability of further cuts in feeding-stuffs came out in June, 1940.

being served timeously. With the coming of the grass season these difficulties largely disappeared.

Fertilisers.—The fertiliser position was on the whole very satisfactory at the outbreak of the war. Accumulated stocks of potash enabled makers of compound manures to supply potash in all mixed manures previously containing that ingredient. It was thought expedient, however, to reduce the percentage somewhat, so that a carry-over of this fertiliser to the 1941 year could be assured. The amount of artificials used for the 1940 crop was considerably in excess of the normal.

Pests.—The chief action taken by Committees during the first winter against such birds or animals as cause waste of food, was directed mainly towards the killing of deer, rabbits, and wood pigeons. With a view to assisting Committees to organise plans for the killing of deer and disposal of their carcases, a control officer was appointed by the Secretary of State for Scotland. As a result of organised shoots, large numbers of deer were killed in many of the forests, their carcases being subsequently sent to some of the larger towns, or disposed of locally. The action usually taken by Committees against rabbits was to request proprietors of land adjoining tillage areas to reduce numbers.

Results of the First Season's Campaign.—The additional tillage acreage was practically all laid down to crop by the end of April, but it was not until the June agricultural returns were made available that the acreage results of the first season's campaign became apparent. It was then seen that the actual results fell somewhat short of the expected. The numbers of cattle had increased somewhat, while there was a slight decline in the numbers of sheep. Part of this decline was undoubtedly due to the unusually severe winter and the poor lambing season.

Although the increase of acreage fell short of the quota, the general result, having regard to all considerations, was not unsatisfactory. Many obstacles were encountered. To begin with, there was a background of lean years which had largely exhausted the resources of many farmers. The prices for oats and the best grades of fat cattle and sheep were certainly not encouraging during those critical weeks when the first survey was being carried out. General assurances had indeed been given that farmers would have reasonable returns for their crops, but these were regarded by farmers as being too vague. There were anxieties regarding labour, machinery and transport; there were fears that an unsaleable surplus of potatoes would be left in the hands of the potato growing farmers of Perth, Angus and the northern counties; there were misunderstandings about whether low-ground breeding ewes were desired or were not desired, and there were obstacles to immediate stock

adjustments. In many of the Scottish areas the £2 per acre grassland subsidy could be earned only to a very limited degree, the bulk of the pasture not being more than three or four years old. And, to crown all these difficulties, the worst winter for nearly fifty years was encountered. That the result was what it was says much for the zeal, the patience and the tact exercised by Committees, as well as for the patriotism of the farmers. Throughout the whole campaign a fine spirit was created and fostered between the Committees and the farmers. The story is told of an old farmer of nearly eighty who, when asked if he would plough up a field, replied that he had no equipment, but that if the Committee would plough the field for him he would delve the corners.

The experience gained by Committees during the first nine months of war was invaluable from the point of view of familiarising them with the many and varied problems encountered. The objectives that were gained, though somewhat short of expectations, were well consolidated, and provided Committees with an excellent jumping-off place for launching further assaults. The morale of the attacking forces—Committees and farmers alike—had noticeably improved with every succeeding month. At the end of the first nine months' campaign our farmers were more determined than ever to produce the greatest volume of food of which this land of ours is capable.

AGRICULTURAL MACHINES AND IMPLEMENTS FROM A FARMER'S POINT OF VIEW.

Major JAMES KEITH, of Pitmedden.

THE changes in tools and implements during the forty years I have farmed are amazing, but, apart from special things like milking machines and seed-cleaning machinery, and other things made possible by the use of small power units, they are mainly the result of the change over from horse power to tractor power. Many things, such as the combined harvester and the newer type of potato diggers, are not by any means new, but, when invented, they could only be worked by horse power under the most favourable circumstances. Petrol and oil engines and tractor haulage have made them workable anywhere. The American potato digger, which has become popular in Scotland during the last year or two, is illustrated in almost complete detail in the 1902 edition of the *Encyclopaedia Britannica*, but it was only made a working proposition by the invention of the tractor power take-off.

A wonderful amount of ingenuity has been expended on machinery for various departments of the industry, such as picking dodder out of red clover seed by magnets and iron filings, estimating the percentage of Italian ryegrass in samples of perennial by means of the ultra violet ray—the germinating Italian seeds glow purple, while perennial does not glow at all—and a machine has actually been invented which will separate discoloured peas from white ones.

If manufacturers would exercise the same ingenuity and co-operation in making the wearing parts of their implements interchangeable, it would be an untold advantage. For instance, every plough maker has completely different plough points and shares. They are not as a rule interchangeable with his own ploughs, let alone those of other makers; cultivator points also vary unnecessarily; binder and mower fingers and knives are not interchangeable, although there has been no real improvement of consequence for forty years.

There is one very important thing makers of tractors and implements should agree upon, and that is that all power drive connections be made standard. Nothing could be more provoking than to find, as I did last season, that the attachments on a hired cutlift machine would fit none of three makes of tractors available, and had to be partly reconstructed before a start could be made on an urgent job.

Makers might also avoid small changes which cause much inconvenience without benefit. A potato digger bought in 1938 proved so satisfactory that I bought another of the same in 1939. The makers had in the meantime altered, but not improved, the draw bar, so that the power connection for one would not work with the other, and nearly half a day's work of thirty people was lost while the blacksmith altered the draw bar of No. 2 to make it like that of No. 1.

The whole thing is a major nuisance and unnecessary, as people who are capable of producing the beautiful and ingenious machinery cannot well turn round and say they are incapable of the standardisation of parts common to all machines, which would be a blessing to all farmers, and even more to dealers in machinery.

Tractors.—The revolution made by the tractor marks an epoch in farming similar to that made by the invention of the mould-board plough, the reaping machine and the self-binder. It has put into the hands of the farmer sufficient power to have all his operations done at the optimum time, a thing which was never possible with horse power only. There is no greater source of loss on a farm than having the work behind. With horses only, this frequently could not be helped, but, with the tractor to

hand, either owned or hired, it is almost inexcusable. I don't know if economists will agree with me when I say that a tractor will pay its way on a farm even if used for only thirty days in the year, but I am quite satisfied that this is the case. The pioneers of the tractor suffered pain and tribulation far beyond the comprehension of to-day's users, but they had faith, and the modern tractor is their reward. I attended some tractor trials near Edinburgh in the autumn of 1917, and the impression I brought away was that tractors were simply of no use to the ordinary farmer. Most of them seemed unwilling to start unless three mechanics were present, and, when started, would only run unwillingly, so that the driver had no time to see to his plough. Some of them were possibly quite good machines when mastered, and a few of them may still be in commission. I saw a "Mogul" going quite recently.

To-day the question is not the goodness or badness of the tractors; all of them are pretty good, and can be relied on to give excellent service if reasonably treated. The question mainly is, what is the right tractor for the job in hand, and more particularly, what tractor will most nearly fit all the varying requirements on one's farm?

Up to a few years ago, I was quite convinced that the Fordson was the best for all purposes. It was cheap and simple, spare parts could be had anywhere, it had a good second-hand market and was easily exchanged when partly worn, as there is a very wide market for reconditioned ones on small farms, where the purchase of a new or expensive machine would not be justified even if the farmer could afford it. It was powerful enough to pull a two-furrow plough for most kinds of work, and a single-furrow to almost any depth; it would pull a medium cultivator on most land, and was excellent for binders, threshing machines and all subsidiary work.

The higher-grade tractors are, I think, more economical in fuel, oil and wear, and as design and economy are not likely to be seriously improved in the near future, the purchase of a high-grade machine is amply justified on farms where there is anything like steady work for it.

For very extensive work, especially in cultivation after ploughing, the king of all tractors is the Caterpillar, as it runs over soft ground without packing the land or digging itself in as do the wheel machines, but it is very expensive, and on many types of land the wear and tear on the tracks is excessive. To illustrate my point: a case-hardened ploughshare on dry, hard, flinty Norfolk land may wear up in less than a day, while a few miles away on the soft fens it will last two seasons. It is much the same with caterpillar tracks.

There is some controversy as to the desirability of having tools actually fitted to the tractor, instead of being pulled or pushed, also as to the merits of hydraulic and mechanical lifts. For accurate row crop work, especially on the flat, it is essential to have the tool bar attached to the tractor, otherwise an extra man is required to steer it. A wider headland is also needed for a pulled implement, a matter of great importance in dealing with row crops, but of less importance in general cultivations and for corn crops.

The most difficult problem of all is that of the farmer who has land with boulders and rock. His problem is far from being solved, but I can say that considerable advances have been made in cultivators with compensating tines, which rise when they strike a stone and enter again when it is past.

On the question of rubber or iron tyres, there is no question that "both is best." I keep two sets of each for several tractors, but possibly rubber tyres with a set of strakes, which can come into action on occasion, would suit most farms better.

Transport vehicles for tractor use on farms are in a state of rapid development, and it is difficult to say what will ultimately prevail. Were expense no object, and were it possible to have a variety of vehicles, then a long four-wheeled wagon on the chassis of an old motor wagon is ideal for harvest. It can be pulled between stooks by a horse and taken to the stack by tractor One tractor operates a set of three.

A tipping cart, operated by a screw or ratchet gear, having sides for general carting and racks for harvest, is probably the best for general work. Most of the carts I have seen are too small, made short in an attempt to make them tip easily and sufficiently. Perhaps some ingenious fellow will overcome this difficulty by putting the hinge farther back and operating the tipping gear from the power of the tractor. Also, could not someone devise a power-operated dung spreader to be behind the cart? I always have, and see many others with, dung lying about unspread much too long.

Ploughs.—At one time or other I think I have had twenty different makes and types of plough, and a discussion of them all could fill a book. I began with the old Scotch or Aberdeenshire swing plough, which was of two types, the ordinary, and the high-cutting used in ploughing matches. All that I can say of them is that it is astonishing how an intelligent body of men suffered them so long. They had some merits : they were entirely home produced, and, except for the mould board, could be made by the local smith. The high cutting one also produced a furrow which was easy to

harrow and covered the seed well. It also provided some drainage on wet land, but, against that, dirt of every kind was left near the surface and came up through the innumerable seams of the narrow furrows. The ploughs were also very heavy of draught and difficult to hold.

The American type of plough, of which the Oliver 110a is a well-known example, gives very much more work per hour, because, even if the horses cannot move faster on stony ground, the furrow can be made as much wider as to increase the area ploughed from 50 to 100 per cent. The furrow is better turned and dirt much less likely to come up at the seams, while the seed when broadcast can be just as well covered by a turn of a spring tooth harrow, or by the use of a drill sowing machine. No greater help to getting on with the work in war-time can be imagined than faster ploughing, as having this done seasonably and in time affects the whole farm economy—sowing at the right moment has been definitely proved to affect the yield of crops almost beyond belief.

The choice of a tractor plough, with all its various range of coulters, disc or knife and skimmers, must remain a matter for individual taste and judgment as to suitability for the work in hand and the power of the tractor. My own preference for preparing root land is for a single-furrow plough which will turn a furrow of almost any depth and up to 18 inches wide. The one I use is perfect on my Norfolk farms, but in Aberdeenshire, where there are a great many fast stones and rocks, the breakages of the part which carries the point are so great as to render the plough almost unusable. For deep work it is very advisable to arrange the draw bar to allow the tractor to run with all its wheels on the land, and not have two in the furrow. This can easily be done, and is a great saving on the tractor bearings. For general work, a two-furrow plough, convertible to a three-furrow, is most useful. Wide furrows and short digger boards are advisable for speed and cleaning effect on most land.

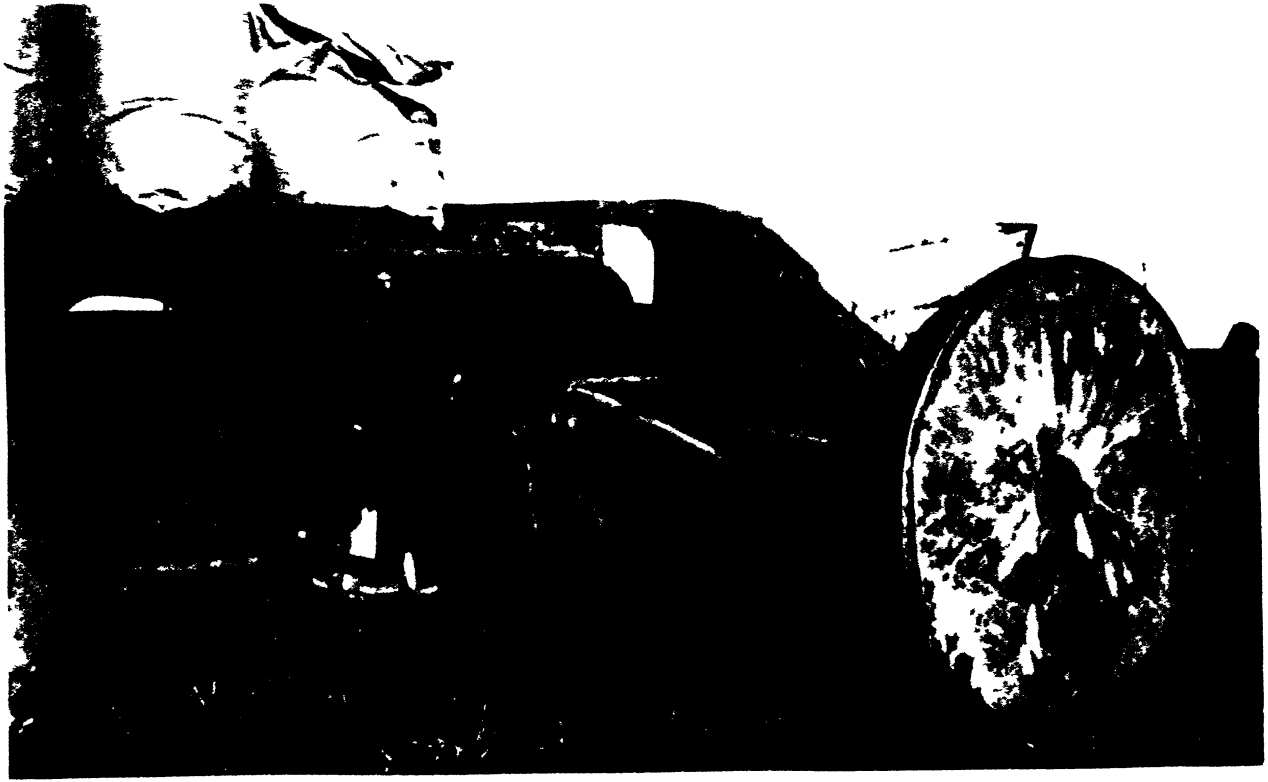
A very important thing in the choice of a plough is the cost of renewing the wearing parts. This is particularly important on stony land, where there are breakages as well as wear and tear. A great many ploughs have enormous shares, the whole of which has to be scrapped when the point becomes blunt or breaks. This is most wasteful, and it is difficult to understand why makers persist in them. I bought a double-furrow one-way plough some years ago which did very beautiful work, and finished the field as level as a table, but it had the fatal fault of a large, expensive share with no renewable point, so has had to be retired, greatly to my regret. Had it had the renewable point I would now be using a number of them.

Disc ploughs are popular in some places, but from anything I have seen of them they don't appear to fit well into the best British farming practice, although some people claim to have performed prodigies of work with them.

Cultivators and Harrows.—The gyrotiller is easily king of all tools for really breaking up and thoroughly cultivating land, either ploughed or unploughed. I was so fascinated when I first saw it, that I almost contemplated buying one, but fortunately the price, £6000, restrained me. It seemed to be the solution of all ploughing, cultivating, subsoiling and other difficulties. It is extraordinarily versatile, and will do anything from grubbing out a heavy overgrown hedge and levelling a bank, to backing into and cultivating the square corner of a field as neatly as a man with a spade. It will break up the hardest field in summer, pull out roots of trees, or cultivate any chalk or pan to a depth of 18 inches with no difficulty whatever, so long as the land is free from rock or large boulders.

A fairly extensive experience with it has made me doubt its universal benefit—land is rather difficult to work after it, stones were brought to the surface which would have been just as well left down, and the mass of loose soil has made carting of sugar beet or other roots almost impossible in wet weather, the cart wheels sinking so deeply. In my own experience, marked benefit over ploughing has been observed on two occasions, once when swedes on a sandy land stood a drought and cropped much heavier in the gyrotilled half of a field, and on shallow soil over chalk, where the crops, sugar beet, barley, and grass and clover were all markedly better. It is often recommended for breaking in rough land, but, unless there are very large roots to deal with, the single-furrow tractor plough is better. The gyrotiller makes such unmanageable heaps where there is tough sod.

For efficiency in throwing up weeds, especially knot grass (roots of the bulbous rooted tall oat grass), I doubt if anything equals the old five-tined grubber with broad spade points to the tines, but for clean land there is a multitude of good and efficient machines. They all have efficient lifting gears, and the spacing of the tines can easily be altered. I have a strong preference for those with rigid fixed tines over those with springs of any kind, as they generally do their job more thoroughly. For use on stony land, one can have a cultivator the tines of which, though rigid, are balanced one against the other by means of chains and pulleys. When a tine catches on a stone it rises and clears it, the neighbouring tines being pulled slightly forward in the process through the operation of the compensating chains and pulleys. The idea is borrowed, I think, from the Australian "stump jump" plough. In any case, it is an efficient and reliable implement.



The Distributor (front view) [illegible]

The ordinary spring tooth harrow is a very well-known and efficient implement for secondary cultivation, its one fault being that it is rather inclined to bung up if there are many weeds, and for after-harvest cultivation it gets badly filled with straws.

The after-harvest cultivation of stubbles seems likely to become a more generally prevalent operation than it is at present. I have made a practice of doing most of my stubbles in Norfolk for some years. The earlier harvest in England makes an excessive growth of weeds after harvest possible, and much working of land in spring frequently makes the germination of seeds doubtful in the dry climate. In Scotland, especially in the north, the later harvest, and what used to be the almost universal custom of ploughing stubbles immediately after harvest, made the practice less necessary, but, now that stubbles are more frequently left unploughed to allow the application of dung on the surface instead of in the turnip drill, the situation is changed. After the early harvest of 1940 and the moist conditions following the July rains, the spread of grass on stubbles has been amazing. Cultivation may not always kill the rubbish, but it will prevent its spreading, and also cause seeds of annual weeds to germinate and be destroyed.

The ordinary cultivators are excellent for a first and second breaking of the surface, but an implement which will keep the surface stirred two or three inches deep without bunging up, and wide enough to do 30 or 40 acres per day, is what is wanted. I think a tool constructed with two rows of spring tines, and made self-clearing on the lines of the Wilder pitch-pole harrow, could be made, but I have been unable to find it. The Wilder pitch-pole is a model of ingenuity and efficiency for many purposes, but the ones I possess are too narrow, dig in too deeply, and are too dead and rigid for the purpose. The spring tine has a lifting and shaking effect not possible with anything rigid.

The disc harrow is an implement which tractor power has made popular in this country, and for work such as preparing lea fields for turnips or potatoes, and for all cultivating where great depth and cleaning effect are not needed, it has no equal. It gives great cultivating effect without bringing weeds, sods and clods to the surface.

There is a multitude of types of spiked harrow for every possible kind of land and purpose. In principle there is little change in sixty years. The wider ones to be pulled by tractors work better if the main yoke is supported by wheels. The method of fixing the tines is rather important; screwed tines should have square nuts and an oblong washer, one end of which can be bent down against the side of the frame and the other up against the side of the nut; this effectively prevents unscrewing in work.

The various driven and wedged types have all their special merits, depending on the skill of the blacksmith who maintains them.

For harrowing pastures there is nothing equal to the flexible Aitkenhead harrow, although some of the spiked chain harrows are good when new, but they cannot be sharpened. A light one I had was most effective for covering grass and clover seeds.

Seed Sowing.—The broadcast grain sowing machine has retained its popularity in Scotland for several reasons, mainly because of the great speed with which a single horse and man can cover the ground in the uncertain climate. It also has the advantage that the seed, being less deeply covered, comes through quicker than if put in by one of the modern disc drills, which tend to cover it rather too deeply.

In dry districts the drill is almost essential, as much of the shallow broadcast seed may not germinate, especially the thick-skinned oats. Even in Scotland, the drill is gaining in favour, owing to the undoubted saving in seed, and because of the increasing use of the American type of plough. For tractor use, I have found that three 7-ft. drills on a suitable hitch makes a speedy and efficient unit. It needs a fairly strong tractor—a Fordson will hardly do it on soft land. The sowing width of 21 feet is faster than the widest of single tractor drills, and the three machines follow uneven ground better than one wide one.

Manure Distributors.—No implement on the farm is more abused than the manure distributor, almost any make of which, when new, will sow dry, powdery manure well, but none of which, with the possible exception of the Wallace rotary machine, will sow damp, lumpy stuff, and it is hardly reasonable to expect them to do so. Makers of manure are becoming more alive to delivering manures in sowable condition. This applies more especially to nitrogen, and to the new concentrated mixtures which absolutely must be sown evenly.

In the past forty years I have had fourteen or fifteen different makes which have been bought and discarded for various reasons. It would be interesting to give a detailed list of the reasons for discarding them, but to do so might hardly be fair to the makers, as, given dry manure and proper attention, all of them would work. Some were too simple and unreliable in adjustment, in an effort to make a very cheap machine, others were too complicated and very expensive to maintain; some had not a wide enough range of sowing, or would sow well when wide open, but badly or not at all with small quantities; others were very difficult to clean; and so on.

One common fault I think they all have, and that is insufficient protection from the weather, otherwise a weatherproof lid or cover. None of them have proper back and front wind aprons

or attachments for holding these, and it seems to have occurred to none of the makers to fill the wheels with sheet iron to form end wind screens. Makers seem to assume perfect weather.

For top dressing large areas of corn or grass with small quantities of manure such as nitro-chalk, there are useful attachments to go on the back of a motor wagon, but these I have seen are unsuitable for dry, powdery manures, except on perfectly still days. For spreading large quantities of lime and slag, I have found that an ordinary distributor fitted with a draw bar to fix easily to an attachment on the back of a motor wagon will save an incredible amount of very heavy, disagreeable labour.[1] The box of the distributor needs to be enlarged to enable the man or men on the lorry to pour in the stuff easily. With this arrangement, the lorry can come with a load and drive right into the field, and go round distributing several tons per hour. Those I use can sow up to 30 cwts. per acre, and a contractor has put on several thousand tons of lime and slag in the past season or so. The one drawback is that it cannot usually be worked on ploughed land. On ploughed land, however, one can work the same scheme with a tractor pulling a two-wheeled cart, with the manure distributor attached.

There are one or two points to be noticed—the extended hopper of the distributor must slip easily under or over the tail board of the wagon, otherwise breakages will take place at turning, the wheels of the distributor must be disced with sheet iron and proper wind aprons fitted fore and aft, as a contractor cannot well be expected to knock off every time the wind rises. I would also suggest a canvas cover for the distributor, so that it will remain in working condition after a night's rain.

For a number of years I have used three manure sowers pulled behind a tractor. This gives a great speed on large fields of corn, or roots to be sown on the flat, but is not so convenient where ridges or drills are raised before sowing the manure. A tractor of the Fordson type easily pulls three eight or nine-foot machines.

One device which saves a good deal of time and labour is fitting a manure sowing box to a horse hoe, so that four rows of sugar beet can be top dressed at the same time as they are hoed.

Harvesting and Haymaking Machinery.—The binder design has not altered materially in the past forty years, except in detail. They are becoming almost universally hauled by tractors instead of horses. This has made the use of wider machines more practicable, and the old 5-foot binder when worn out will almost always be replaced by one of 6 feet, or of 7, 8 and 10 feet in the case of power drive machines where the

[1] Photographs of this machine will be found between pp. 126 and 127.

mechanism is driven directly from the tractor instead of from the binder main wheel. This power drive is a very great advantage, and experience of the 8-foot machine over a number of seasons makes me think it an ideal implement. I have a 10-foot machine, but, except in pretty light crops, the mass of stuff coming up is rather more than the cloths, packing mechanism and knotters, etc., can deal with. It is difficult to suggest much improvement on the binder; the one thing I have badly felt the need of recently was waterproof cloths which would enable grass intended for silage to be cut when damp. Of course it can be cut by a mower when wet, but the bound sheaf is much easier to pitch and unpitch and is less wasteful; in filling a tower silo, the cutter and blower will handle 50 per cent. more if the crop is in sheaves. For pit silos, loose stuff is probably best

The combined harvester has made a good deal of progress in the past few years in the drier districts, especially for harvesting wheat, and to some extent barley. Oats seem unwilling to stand to the necessary degree of ripeness. Access to a drying plant is almost essential if full use is to be made of a combine, although last harvest much corn was dry enough even in the mornings and evenings to do without drying. Handling the grain loose by means of an elevator and hopper on the combine which will discharge quickly into a wagon is an immense saving of labour in the field, but it may involve special arrangements and elevators at the granary or drier

Handling grain loose when threshing in the field is a great saving of labour if the grain is to be bulked and not sold direct. I had two portable threshing machines fitted with elevators to raise the grain high enough to allow it to run through a wooden box spout into a wagon. The spout was made large enough to hold the delivery while changing wagons. By this arrangement, one man with three wagons is able to handle the grain from two threshers easily, if there is a suitable pit and elevator at the barn. The saving of labour is immense, but the method is practicable or necessary only on a large grain growing farm. The arrangement and domestic economy of most Scottish farms require most of the threshing to be done in the steading.

The ordinary grass cutter or mower used in this country has always been made too narrow, 4 ft. 6 ins. or 5 ft., owing, I think, to that being about the maximum width for which the wheels would supply power to the knife when cutting tough permanent grass hay.

Some years ago I persuaded a firm of makers to supply me with an extra cutting bar 6 ft. long to a new machine I was buying. I thought it would be handy for cutting thistles or topping pastures. Experience has shown that the 6-ft. knife cuts ryegrass

and clover hay just as well as the narrower one, and I wonder why I have any of the narrow type.

A very great improvement in mowing machines is the power drive from the tractor. I have had one with a 7-ft. cut for some three years, and have found it a perfect tool for speed and efficiency. This year we found a new use for it in cutting marrow stem kale with thick stems, a hard job to do by hand, and one which completely beats the ordinary horse mower. The power drive mower was perfection, and in ten minutes it cuts as much as a man would cut by hand in half a day.

To go fully into all the variety and detail of haymaking sweeps, topplers, windrowers, side-delivery and other horse rakes, elevators and horse forks, and schemes for baling in the field, etc., would take a long article in itself, and I will just say that, given a mower, a toppler and horse rake, some 10-ft. tripods and good weather, anyone can make hay fairly economically.

The ideal rake is one that will skim lightly over the surface collecting all the straws but no stones, stubble and earth. This was nearly accomplished in the light American rakes which used to be in the market, but which now seems to have quite given place to the heavier English rakes, which, in addition to raking, do a fair amount of cultivation if the land is at all soft. It must, however, be said for them that they are most substantial, and stand up to heavy work, such as hay collection.

Apart from improvements in the lifting gear, the genius of the man who invented the expanding horse rake deserves special commendation. This machine does 50 per cent. more work than an ordinary rake with no more horse or man power, and remains manageable at gates and on roads. Before I owned one I thought it a complicated contraption, but closer acquaintance has proved it to be a most useful and economical implement.

Since grass silage has become suddenly prominent, the question of how to handle the grass becomes an urgent matter. The first thing is to prepare the surface of the fields to be cut by killing the moles, gathering any loose stones and rolling with a heavy roller. This is even more important than with hay, as in cutting young leafy grass it is essential that the knife lies right down on the ground.

The ideal machine is no doubt the cutlift, but they are so scarce and expensive that most farmers must make good with the mower or binder. If very fine quality is to be made, the mower. must be used and the grass gathered by a rake. One farmer tells me he found the rowing of it with a side delivery rake very effective. Where it is to be chaffed, I am inclined to sacrifice very high quality for more bulk and greater total yield, and cut with a binder.

Potato Diggers.—The potato digger has always had the reputation of being about the most inefficient tool on the farm, leaving a lot of potatoes in the ground and damaging most of those it got out. The old spinner digger certainly damaged a great many, especially in stony ground, and a good many attempts have been made to remedy this, but usually where they damaged fewer they buried more. One machine, with a slow working vertical wheel and a horizontal wheel to sift out the earth, was much the best of this type, but I think that the American elevator machine is infinitely ahead of any other.

The ones I have are not fitted with a variable speed gear, which would be a very great advantage—it is, I believe, fitted to some machines.

If the elevator is run too fast where the earth goes quickly through the rods, damage is being done to the softer varieties of potato.

The main advantage of the machine is that on clean ground almost every potato is left on the surface, and in a narrow row which makes gathering so much easier that one-third fewer pickers will keep a machine going, a matter of importance in war-time.

Milking Machines.—I have used milking machines now for a considerable number of years, and, after a somewhat disappointing start, found them thoroughly satisfactory. The first machine I had was in Norfolk, and was a very decided failure, owing quite definitely to the men in charge making up their minds that it was no good, and in any case only doing a poor man out of a job. Although I explained, time and again, that, if the machine worked well, I would employ more men and keep more cows, it had to be given up. I afterwards changed both the men and the machine, and, since then, it has worked to perfection. My next one was on an Aberdeenshire farm, where I had become tired settling differences of opinion between milkers. The man in charge took the greatest possible interest, and it was a complete success in every way, as have been several others installed since. The whole secret of successful machine milking lies in having a keen, interested man in charge. I use several machines of two makes and both are thoroughly satisfactory. One is slightly more complicated than the other, but not seriously so, and any advice I could give as to which to buy would be to take the one sold by the nearest firm who deals in them and stocks spares. Frequent small replacements are needed, and it is most convenient if a dealer near at hand stocks them. As to motive power, where main electricity is not available,

I think the small Diesel engine is easily the best—it starts very easily, and has no plugs or magnetos to go wrong, while the fuel is cheap, is not dangerously inflammable like paraffin and petrol, and has the merit that it cannot be used for other purposes.

There is just one other point worth consideration in installing a machine, whether to have a bucket plant to milk the cows in their stalls, or a plant of the auto-recorder type where the cows are milked in bails separate from their ordinary stalls. I have several of both, and my opinion is quite definite that the bail type is best, especially in the case of a large dairy where the cows may be in several houses. The advantage of having cows all milked and rationed directly under the eye of the principal man is very great. Some people may think the system complicated, but the cow is an intelligent creature, and, after she knows what to do, she does it with all the orderliness of a theatre queue. I have not tried the outside movable bail system, but it appears to work quite well, and its exponents speak highly of it; but, before adopting it, I would advise anyone to make a twenty-four hours' study of one in bad winter weather, and see if their temperament can stand it.

I need hardly say anything of coolers and other dairy appliances, as they are so well standardised. The very cheap low pressure steam boiler I found rather unsatisfactory, and would strongly recommend one capable of working at not less than 40 to 50 lbs., except in the very small dairy where low cost is important.

Storage of Implements.—Possibly nothing illustrates better the semi-bankrupt condition of the farming industry generally over the past forty years than the fact that, notwithstanding all the improvements on implements and multitudes of new implements introduced, there is not one farm in twenty which has a really good implement shed, and all sorts of valuable implements are left outside to deteriorate until it is possible to get them packed away in some hole or corner. What I mean is not some inconvenient awkward place into which a partly dismantled binder can be pushed by the united efforts of all the men on the farm, and then all sorts of things piled on top of it, but a large, roomy, well-lighted house, where all the implements can be stored easily and with sufficient room to clean and overhaul them. A shed of this description 100 feet by 45 cost just before the war about £300, and could hold all the implements on the largest of farms. I am pretty certain that suitable sheds would liberally repay their cost on any farm, but, as I say, their almost universal absence is a sad symptom of the state of the industry.

HOME-GROWN FEEDING-STUFFS.

Professor J. A. SCOTT WATSON, M.A.

A Conference on the use of Home-grown Feeding-stuffs was held at the Rowett Institute, Aberdeen, on October 31st, 1940. The discussion was opened by Professor J. A. Scott Watson, University of Oxford, and the following is the substance of his paper.

IF the country should still be at war in the autumn of next year, as seems more than possible, stock-feeders will very likely have to face a more difficult problem that those of the two preceding winters. If this problem is to be solved, the farmer must give early consideration to his cropping programme for next year.

There are three sources to which we may look for helpful ideas.

First, there is the practice of past generations of Scottish farmers, who somehow managed to win through the winters of their time with smaller cake-bills than we have been accustomed to pay in recent years. But if we are to apply their experience, we must not forget that many conditions have changed in the interval. For one thing we have been carrying more winter stock in proportion to our acreage of roots and other winter food. Much of our pasture has been greatly improved and our pasture acreage has increased, so that we are able to graze more animals; but we have achieved no correspondingly large increase in the production of winter keep. It may be, therefore, that we shall have to reconcile ourselves to some reduction in numbers—not only of pigs and poultry, but also of sheep and beef cattle. It was one of the cardinal mistakes of German farmers, between 1917 and 1920, that they clung to their livestock too long. They were left with herds of cows that produced very little milk, and with a great mass of meat-producing animals that could not be fattened. We are continually tempted, under war conditions, to keep more animals than we can feed adequately. The temptation is one that we must fight against; we must remember the old proverb—" If it will not pay to feed, it cannot pay to starve."

We must also remember that there have been considerable changes in the relative proportions of the different kinds of stock. All over Britain there has been a big increase in dairy herds; in the north-east of Scotland there has been, in addition, a very large increase in ewe flocks. Roots and straw formed the basis of old rations for wintering and fattening cattle. They formed a good basis, and still do so, for these types of stock. Again, turnips provided the basis of the ration for fattening hoggs, and they still provide a good basis. But the milch cow and the breeding ewe both require rations containing substantial amounts of protein, and

hence it is essential that we should find some home-grown substitute for the high-protein cakes that we have become accustomed to use in quantity. Nevertheless, it is a very fortunate thing that Scottish farmers have substantially maintained their root acreages in recent years. In parts of the south of England one of the main difficulties is that the root area has so greatly declined.

A second source of ideas is the practice of certain other countries that have somehow managed to increase their outputs of livestock products with relatively small imports of maize, oil-cakes and other feeding-stuffs. Holland and Denmark have undoubtedly done so.

In the grassland dairying districts in Holland the chief line of development has been the improvement of pastures by more intensive manuring and better grazing management, combined with the substitution, in quite a large measure, of grass silage for hay. Thus the grassland is not only made to produce more, but an increasing proportion of its output is converted into a fairly concentrated type of winter fodder.

The Danes, on the other hand, as is well known, have based their livestock industry on arable farming. Their climate is not unlike that of the east of Scotland, and their soils are in general what we should call light. As we should expect, they have not only maintained but have largely increased their root acreage in recent years. At the same time they have provided additional summer keep by improving the two-year ley which is an almost universal feature of their farming.

There are one or two points in Danish root-growing that are worthy of note. On the one hand the Danes use larger amounts of artificials, and especially of nitrogen, than is the custom in Scotland. This is partly because the Danish farmer has a large root break—ordinarily a full fifth of the whole area of his farm. The available dung must, therefore, be spread rather thin. Again, the farmyard manure is mostly produced by dairy cows getting something like the minimum amount of high-protein cake, and hence it is not very rich. Under war conditions our supplies of dung may decline, and the quality, owing to the reduced supplies of cake, is certain to deteriorate. If we are to maintain or increase our root breaks, and also to maintain our yields, we must be prepared to spend more freely on artificials, and especially to give heavier dressings of nitrogen. Fortunately nitrogen manures are in abundant supply.

A second point is that the Danes put a much larger proportion of their roots into safe winter storage than we do. It is true that their winter is, on the average, a little harder than that of the north-east of Scotland, but here, as there, storage is essential if we are to count on our root crops to last out the winter. In normal

times we have had to balance the risk of frost damage against the labour cost of storage, and we have been able to make up for a loss of roots by increased purchases of concentrates. But clearly, during war-time, we cannot afford to run the risk. The Danes have partly solved the labour problem of storage by the use of turnip-lifting machines. When the last machinery census was taken, in 1936, there were nearly twenty thousand root lifters in Denmark. Here is a case, then, where we seem to have fallen behind other countries in the matter of mechanisation, and it may be a point worth consideration whether we should not follow their lead. The Dane gets another advantage from the early harvesting of his root crops—namely, that he uses a very substantial part of the tops for feeding. What he can use during the lifting season he feeds fresh; some part of the balance he puts in the silo. Under present conditions we must try to look after a variety of oddments that are not worth saving in ordinary times, and the feeding value of tops, especially swede tops, is considerable.

Roots are, in a real sense, a substitute for imported maize and other cereals, but they are no substitute for imported oil-cakes. For part of his protein the Dane still relies on pulses. On strong land he may grow beans, and it is well recognised that beans can meet the present needs of the British farmer who has a suitable soil. But most of Denmark is light land, and many Danish farmers grow a good deal of grain with no other idea than to use it for stock-feeding. In such cases they grow a mixed crop. The common mixture is about two bushels each of oats and barley, with quite a small addition—one or two stones—of field peas. The farmer is convinced that he can thus grow more weight of grain per acre than from a pure cereal crop. The peas contribute more to the mixture than one might expect, and the mixed grain produces a meal with a fairly high protein content. The peas are not enough to cause serious difficulty in harvesting, and the mixed straw is both more palatable and of higher feeding value than pure cereal straw.

In the third place we may look for guidance from research centres such as the Rowett Institute and from scientific workers generally.

One problem that is being investigated by chemists is the better utilisation of straw—the one commodity available in greatly increased amounts under war conditions. It is well known that the feeding value of straw depends on a number of things. North-country oat straw is a good deal better than south-country. Some varieties produce far better straw than others. Again, quality depends on the stage of ripeness at which the crop is cut; the total food value of grain and straw together is increased if we cut

before the crop is fully ripe. Finally, of course, the harvest weather makes a vast difference to the nutritive value of straw.

Lately the chemist has turned his attention to the possibility of improving the digestibility of straw by chemical treatment. The fact is that straw contains a large amount of material—soft cellulose—that is, in itself, quite readily digestible by cattle and sheep. But a good deal of this soft cellulose is protected by a coating of a hard indigestible substance called lignin. If this lignin is dissolved and removed, what is left of the straw has a much increased food value. The process is simple enough; it consists in soaking the chaffed straw in a weak solution of caustic soda, and in thoroughly washing the remaining pulp with clean water. Digestibility trials have shown that good oat straw can be converted into a material of nearly the same food value, dry weight for dry weight, as sugar-beet pulp. There is some loss of dry matter in the process, and the small amount of protein that the straw contains is practically all carried away in solution; but it is roughly true that the food value of a ton of straw is doubled by the treatment. The process was described in the last volume of the *Transactions of the Highland Society*.[1] Numbers of practical experiments are being carried out this winter at the Rowett Institute and elsewhere. It would seem that, where the farmer has an ample water supply, the process may be worth consideration.

Among other developments in which the scientist has played a part is the substitution of marrow-stem kale for turnips as an autumn food. Kale has several advantages. It is more dependable, in dry seasons, than turnips. It is more resistant to finger-and-toe than the common varieties of turnips and swedes. It has a higher protein content and is, therefore, a more useful ingredient in the milk ration than roots. Finally, it responds better to intensive manuring, especially with nitrogen. It is thus an efficient means of turning nitrogen manures, which are plentiful, into protein, which is scarce. In most experiments kale has given a profitable response to dressings of three or four hundredweights of sulphate of ammonia per acre, in addition to dung and other artificials. It must, indeed, be borne in mind that such generous treatment makes the crop less resistant to frost, and that any part of the crop intended for December and January feeding should be less generously treated.

Next let us turn to grass silage which, as is generally admitted, has an important part to play in the food production scheme. Let us, however, first admit that the making of grass silage is not an alternative to ploughing up. If we break up a grass field and use it for the production of roots and oats, we shall generally get

[1] Fifth Series, Vol. LII. (1940), p. 16.

a much higher yield of carbohydrate—*i.e.*, of fattening food—than we can get from grass by any means of preservation. But roots, oats and straw are substitutes for imported maize and other starchy foods. They are no substitutes for imported oil-cake. One substitute for cake, as we have said, is beans or other pulse seed. The other is silage made from young grass, and it seems that there are very many cases where grass silage is the better means to the end. Ploughing up, for roots and grain, and the ensilage of young grass are thus two things that should go together.

The ensilage of grass may be looked at from two points of view. It may be regarded as a means of making use of an accidental surplus of grass—lattermath for instance. On the other hand we may set out to use a field specially for silage, instead of for hay. We must then treat the field differently—somewhat in the same way as grass used to be treated for the production of green food for the old town dairies. For this purpose a grassy sward, often consisting of Italian ryegrass, was intensively manured with nitrogen, and was cut a considerable time before it reached the hay stage. The field was generally mown three times during the season. Nitrogen manures were given not only in early spring, but also after the first cut, and sometimes again after the second. Where we are dealing with young grass that is later to be used for grazing it is, of course, necessary to use nitrogen with more discretion, but it is an important fact that early cutting for silage, as against later cutting for hay, is of great benefit to the sward. It is well known that the too late cutting of hay, and the late feeding of a heavy lattermath, have very bad effects on the subsequent value of the sward for grazing.

As regards the technique of silage-making, the use of concrete, wooden or other containers is not necessary. Provided that a well-drained site is available, the pit silo produces perfectly satisfactory results. The use of molasses is to be strongly recommended, more especially where the grass is young and leafy or where the proportion of clover is high. Plenty of good silage has been made without molasses, but the addition of sugar is a great insurance against the wrong type of fermentation.

One other point remains to be made. If we are to have more arable, and if we are to use more of our grass to produce winter food, we must somehow contrive to make our remaining acres of pasture produce more grass to the acre. Moreover, under present conditions, we must seek means of pasture improvement that not only produce results, but produce these results quickly. We must turn, especially, to our poorer pastures—the land that has been left down in grass because it has not paid to plough. There is now no doubt as to which is the best and speediest scheme of

improvement in such cases. Wherever we can plough, we should plough; we should lime if necessary; under almost all circumstances we should give a dressing of phosphate. Finally, we must re-seed either with a nurse crop of an early-ripening variety of oat, or else without a nurse crop at all.

Summarising, we must seek a solution of our problem along these four lines:—

1. We must struggle to maintain our root acreage and to maintain our yields of roots. To this end we must be prepared to use more fertilisers and especially more nitrogen. We must aim at safer winter storage of turnips and swedes. We must consider whether we should not benefit by replacing part of our turnips with kale.

2. We should consider the possibility of producing a better-balanced concentrate than oats. Beans or some kind of mashlum are the best possibilities.

3. In many cases our best and cheapest method of producing high-protein food, in bulk, is to make molassed ensilage from grass.

4. We must make our remaining pasture acreage more productive. The quickest means to the end, as far as the poorer pastures are concerned, is to plough up and re-seed.

FLAX-GROWING IN SCOTLAND.

John Stirling, N.D.A., N.D.D., C.D.A.D. (Hons.).

The flax plant (*Linum usitatissimum*) used in commerce in this country, is a type of linseed grown primarily for its fibre content. It is this fibre which provides the raw material used in the manufacture of linen. In normal times, the Scottish linen trade utilises about 25,000 tons of fibre: roughly the produce of 150,000 acres. All of this, with the exception of a few hundred tons, had to be imported. Russia and the Baltic countries supplied over 90 per cent. of the requirements, the other chief exporting countries being Holland, Belgium, France and Northern Ireland. Altogether some 70,000 persons in the British Isles were engaged in linen manufacture, and the value of the net output was in the neighbourhood of 7½ million pounds per annum.

Now that, with the exception of any from Northern Ireland, all the supplies of flax fibre from these countries are cut off, it will be seen how imperative it has become to foster the production of flax in this country, especially for war purposes such as the manufacture of aeroplane fabric, canvases, sailcloth, tenting, fire hose, and so on.

In a previous article written for the April, 1937, issue of this

Journal the writer predicted that a large increase in the acreage devoted to flax growing was to be looked for in the next few years. At that time the Flax Spinners' and Manufacturers' Association of Great Britain, in conjunction with the Linen Industry Research Association, was carrying out a series of flax-growing experiments to evolve new methods of harvesting and processing flax fibre As the result of these and other tests, plus the impetus of the war, the production of so-called natural fibre has taken precedence over other methods of processing, so that what was begun as an interesting experiment is now well on its way to being the established practice. The acreage in 1939 was greatly increased in 1940, and there is likely to be another large extension in 1941

The production of flax by peasant labour no longer exists in Scotland but this is still the principal method of production in Northern Ireland There the farmer not only grows the flax, but also steeps or rets it, has it scutched at a scutch mill and then sells the fibre to the merchant.

Under more modern methods, a company is formed which starts a flax factory in a suitable district The company supplies the growers with seed and then agrees to purchase back the dried crop when it is properly harvested At the factory the crop is then de-seeded and the straw processed into fibre by whichever method is thought desirable This may be by any of the following —1 Water retting—either dam or tank 2. Dew retting 3 Chemical retting 4 Decorticating, which includes the production of natural fibre, and, as already indicated, is the method now being employed It has the advantage that it entirely eliminates the costly retting processes and, being entirely independent of the weather, makes for much better organisation of labour

Flax growing on factory lines has had many ups and downs in the past, but throughout all its trials and tribulations one fact has remained outstanding, and that is that Scotland can and does produce the heaviest crops of flax which, when properly harvested, yield as good quality fibre as any grown elsewhere in the British Isles. Bearing this in mind, and with the knowledge that most of the past difficulties have now been overcome, there is every reason to feel optimistic about the future of flax growing in Scotland

On the outbreak of this war the Ministry of Supply took over control of all flax and arranged the growing programme for 1940. It was decided to have 8 factories each handling a suitable area of flax, and that 7 of these factories should be in England and 1 in Scotland The Scottish factory was to be run by the Scottish Flax Co, Ltd, with headquarters at Blairgowrie. When the

invasion of Holland and Belgium took place it was immediately decided to rush over more seed from there and to increase the acreage here up to the limit which could be grown so late in the season. On the second appeal for growers being made Scottish farmers responded nobly, increasing their acreage by a further 1,000 acres. In England the increase was also 1,000 acres, but this was spread over all the other factories.

The campaign opened early in January and the main points of the contract offered to the farmers were:—

(*a*) The flax company supplied sufficient seed for sowing at 28s. per cwt.

(*b*) Pulling machines were to be made available for harvesting at a charge of 5s. per ton of crop pulled.

(*c*) The grower undertook to deliver the dry crop free of expense at the factory, but allowance up to 5s. per ton was made on haulage over 10 miles.

(*d*) Sample lots were to be taken at random and processed separately to determine the seed and fibre content of each crop.

(*e*) Payment was to be made at the rate of £6 5s. per ton of crop delivered, plus 25s. for every 1 cwt. of cleaned and dried seed, plus 12s. per ton of crop on every 1 per cent. yield of fibre over the standard of 10 per cent.

(*f*) An interim payment of £5 per ton was to be made on 1st September or on date of delivery if later. Final payment was to be made to the grower on or before 1st January.

To meet the increase in the cost of wages the Ministry of Supply sanctioned a further payment of 29s. per acre.

At this rate of payment an average crop yielding 2¼ tons per acre with a seed yield of 2 cwts. per ton of crop and yielding 11·9 per cent. fibre shows the following gross return:—

Basic price - - - - - -	£6	5	0	
Seed 2 cwt. @ 25s. per cwt - -	2	10	0	
Bonus on fibre 1·9 per cent. @ 12s. -	1	3	0	
	£9	18	0	per ton

At 2¼ tons per acre plus the extra 29s. per acre this equals £23 14s. 6d.

This system of payment is an improvement on the older system of paying on tonnage of crop only, as it takes into account both the seed and fibre yield. The heaviest crop per acre is by no means always the best yielding crop.

In practice, however, it caused a good deal of extra labour

sampling the crops, and still another system of payment is suggested for 1941. (See p. 145.)

There was some delay in getting the seed forward in the spring, but a few sowings took place in the middle of April; the weather then broke and held up sowing till the last few days of the month and the beginning of May when the bulk of the crop was sown. It was just then that the appeal for a further 1,000 acres was made, and to meet this sowings were continued right through the month and into the first week of June. It will be recalled that May and June were very dry months and much of the late sown flax did not germinate until it got the rain in July. Early sown crops looked well all through, but those which had shown signs of weakening made such a speedy recovery on getting the rain that new growers were astonished at their rapid growth (at certain stages of growth flax may stretch 1 inch per day). The net result of the late rain was to increase the bulk of the crop, but at the same time it considerably delayed ripening and made a late harvest later still. It was well into August before harvesting started proper; normally, it is possible to start pulling during the last week in July.

At harvest time the real troubles began. The performance of the pulling machines at first fell a long way short of expectations. This was not altogether surprising as they had been despatched direct from the makers to the farm. Many minor adjustments and alterations were found to be necessary, but gradually, as the season wore on, the machines gave a better account of themselves.

As always, difficulty was experienced with really heavy and lodged crops. It was found much better to have these pulled by hand. The great bulk of the crops was saved in excellent order. A few of the June sown crops were not pulled until the middle of October, and these crops were only harvested with difficulty as by that time all harvest weather had gone.

The next big trouble was in finding transport to convey the crops to Blairgowrie. It was decided to give the farmers who had not yet delivered their flax the option of stacking and thatching it on the farm, the company being responsible for the hauling at a maximum charge of 7s. 6d. per ton. Needless to say many of the farmers took advantage of this offer. It has since been decided to erect temporary de-seeding stations in the growing areas both to speed up de-seeding and to reduce the bulk to be transported to the main factory.

Unfortunately, figures are not yet available giving the full returns to the growers, but it can be said that the crops already received at the factory are averaging 2½ tons per acre. A few crops are giving the very high yield of over 4 tons per acre.

Cultivation.—Cultivations are much the same as for any spring sown grain crop, except that a finer and firmer tilth is necessary. Flax is not the least fastidious as regards soil, though fields with a cold bottom generally grow the best flax. Of more importance is that the field selected should be free from tall-growing weeds. These may not be harmful in a fodder crop, but are decidedly detrimental in a crop for manufacture. As to place in rotation, when so much old ley is being ploughed up these days one cannot do better than sow it on such a field, or, failing that, after the first year's grain. Flax is particularly suitable for this as it is a crop which is absolutely immune to wire-worm, and it has also a remarkable effect in breaking down the old turf. It can follow a green crop, but is never of such good quality, and while it makes an ideal nurse crop to sow out with grass seeds, one cannot expect the same weight of crop, especially in a good grass year.

Manuring on good land is not absolutely necessary. On poorer land and sheep pastures, where there is likely to be a deficiency of potash, the crop will benefit from a dressing of 1 to 1½ cwts. of muriate of potash or its equivalent in potash salts. From ½ to ¾ cwt. sulphate of ammonia may be added to give bulk. These manures should be applied at sowing time. Liming is not necessary. Flax does not require heavy and concentrated manures. Such treatment is definitely detrimental. No doubt it will result in a heavy crop, but also of one of little value, being principally woody stem with a low percentage of fibre and liable to be difficult to harvest. Most growers are finding it does best on their poorer land. Satisfactory crops can be got on land as high as 800 ft. The average yield of crop on the different classes of land would average much as follows:—

Land in poor heart - -	1½ to 2 tons.
Medium land - - -	2 to 2½ tons.
Good arable land - -	2½ to 3 tons.

Ploughing for flax, unless on light soils, is better done early so as to get the full pulverising effect of the frost. Deep ploughing is no advantage, but the furrows should be well inverted to bury all the herbage. Discs are useful where there is old turf, but ordinary harrows do quite well on stubble. Before sowing, the aim should be to obtain a fine surface mould as for grass seed sowing. It is often advantageous to roll before sowing, but, if the seed is to be broadcast, then a stroke of the harrows after the roller gives a covering for the seed. After sowing, one stroke of a light harrow is sufficient, and this should be followed by a good heavy rolling to finish off.

Broadcasting is quite satisfactory whether by hand or seed-barrow provided always that one remembers he is dealing with

a very slippery seed which, given the opportunity, will run like water.

Special drills to sow in 4-inch rows are very useful and ordinary corn drills can be used provided that half the seed is drilled in one direction and the other half at right angles to the first.

The amount of seed sown may vary from 85 lbs. to 1 cwt., but the proper amount for seeding may safely be left to the factory owners to decide as they will have full particulars of variety, germination, etc. The best time for sowing is during April. Earlier than this there is a danger from damage by frost, but later sowings can extend into the middle of May. Experience has shown that later than this is not advisable.

In practice it is time enough to sow flax once all the oats are in and in normal years, if this be done, the flax will probably be ready for harvesting a fortnight before the corn. Nowadays, of course, with earlier ripening varieties of oats and the vagaries of the weather this does not always hold good.

For the 1941 harvest new pulling machines of the Hosking type will be available. These being self-propelled, tractors will not be necessary, and while the pulling device is the same, there is an improvement in the method of conveying and delivering the crop. Growers should realise that with very heavy or lodged crops far better results will be got by hand pulling. The initial cost will be higher, but in the end the increased value of the hand-pulled flax will compensate for the extra outlay. This was the general consensus of opinion amongst this year's growers, as it can truthfully be said that, without the aid of hand pullers, some of the heaviest crops instead of leaving a profit would have been a dead loss.

While on the subject of hand pulling the question arises about opening roads for the pulling machine. If labour is likely to be scarce at harvest time it is quite a good idea to sow the end riggs with oats to be cut green as required; then there need be no delay.

As to the procedure after the flax is pulled, it is difficult to give the best advice, as so much depends on the weather. It does the sheaves no harm to lie a day or so after pulling, as it stiffens the straw and makes for better stooks. Should the weather be broken then, say after a week to ten days in the stook, the crop should be built into "huts" or "frandies," preferably round a tripod or boss with ventilation spaces through to the centre of the boss. If the weather is settled and the sheaves are thoroughly dry, they may be stacked without hutting. If properly built, huts take no harm from the weather, but they should not be allowed to sit longer than about six weeks. After that it is in the grower's own interest to have the flax properly stacked and thatched convenient to a hard road for removal.

Some details of the 1941 programme are now available.

In addition to the factory at Blairgowrie, it is likely that another factory will be set up somewhere in Fife, and a third either in West Perthshire or Aberdeen.

Payment according to grade will be made for the new crop as follows:—

(*a*) Grade 1 crop. £11 per ton for flax averaging in the field between 34 inches and 40 inches in height, good colour, well harvested, etc.
(*b*) Grade 1x crop. £10 per ton. Flax not definitely up to Grade 1 standard.
(*c*) Grade 2 crop. £9 per ton for flax averaging 28 to 44 inches in height, of sound quality, etc.
(*d*) Grade 2x crop. £8 per ton. Flax not definitely up to Grade 2 standard.
(*e*) Grade 3 Crop. £7 per ton. Flax averaging 20 inches or over in height, undamaged, etc.
(*f*) Grade 3x crop. £6 per ton. Flax not definitely up to Grade 3 standard.
(*g*) All other crops at prices to be agreed upon.

Preliminary grading shall be done in the field and final grading shall be determined at delivery.

Grade 1 flax should yield 10 per cent. or over of seed and 13 per cent. or over of fibre.

Grade 2 flax should yield 8 per cent. or over of seed and 10 per cent. or over of fibre.

An allowance up to 10s. per ton is to be made against the grower's cost of cartage or, alternatively, if the grower is asked to stack and thatch his crop, then the company will haul it free of charge and in addition make an allowance for shrinkage in weight during the time the crop has been in stack.

There is no doubt that the great majority of last year's growers were well pleased with the way their crop turned out, and a considerable number have stated their intention of increasing their acreage this year. At the same time many new growers will be required.

LIMING AND MANURING.

W. G. Ogg and A. B. Stewart,
Macaulay Institute for Soil Research, Aberdeen.

One of the most effective methods of increasing food production is to bring the land into the highest possible state of fertility. It costs just as much in seeds and labour to produce a poor crop as a good one, so it will obviously be sound economy to make the soil as fertile as circumstances permit. The most important factors in promoting soil fertility are efficient drainage

and proper liming and manuring. Unless drainage conditions are satisfactory the application of lime and manures may be largely wasted. It is obviously good practice, too, to get rid of weeds as far as possible. Weeds rob the crop not only of actual plant foods, but also of moisture and light, and the presence of weeds means a big reduction in crop yield.

On most of the agricultural land in Scotland the economic limit in liming and manuring has by no means been reached, and increased applications would pay the farmer as well as increase the amount of food which is so necessary for the country at the present time. Field experiments and soil tests have shown that there is throughout Scotland a widespread need particularly for lime and phosphates. In some districts at least 75 per cent. of the soils are deficient in these substances, and in the case of lime many farmers have for years been drawing on the reserves built up in the past.

The Government has recognised this, and has endeavoured by means of the subsidies on lime and basic slag to replenish the reserves of lime and phosphate in the soil. Although the scheme has been in operation for little more than three years a marked improvement can already be seen in many places, particularly in the pastures, but the benefits are also apparent in the other crops in the rotation.

The amount spent by farmers on fertilisers varies greatly, even in the same district and on the same system of farming. On a hundred acre arable farm worked in the ordinary six-course rotation some farmers are spending £25 or less annually on manures, whilst others on similar farms find that it pays them to spend more than double that amount. With present prices it would undoubtedly pay most farmers to apply lime and to manure more heavily. On an average the crop yields could probably be increased by at least ten per cent. by suitable liming and manuring.

Liming.—*The Need for Lime.* An examination of several thousand samples of soil from the North-East of Scotland shows that about 60 to 70 per cent. of them would benefit from the application of lime, and about 40 per cent. of these show a very great deficiency. There is a constant drain on the lime reserves of the soil through losses in drainage, and through the amounts removed by crops and stock. For instance, a two tons per acre crop of hay removes about 80 pounds of lime, and every bullock sold from the farm takes with it some 20 pounds of lime. Many of the crops normally cultivated in Scotland can be grown under fairly acid conditions, but after a time a point is reached when there is a marked decrease in yield, and often the first signs are to be seen in a deterioration of the pasture.

In addition to its direct effect in promoting better yields, lime has various indirect benefits. The improvement in pasture grasses and the encouragement of clover provide more to plough down, with consequent improvement in general fertility. There is an improvement in quality as well as quantity of crops, and animals thrive better. There is also an effect on the utilisation of artificial fertilisers. As mentioned later, sulphate of ammonia can be used to great advantage to stimulate growth, but unless there is sufficient lime present the application of large dressings of sulphate of ammonia may do positive harm. Again, under acid soil conditions, soluble phosphates tend to become fixed in a form unavailable to plants. It is of the greatest importance, therefore, under present conditions, to keep up the lime supplies of the soil, if for no other reason than to make sure that full benefit is derived from the application of manures, supplies of some of which will, of necessity, be limited.

Much of the old grassland which is being broken up in connection with the ploughing-up campaign is very deficient in lime. It is possible to grow oats and potatoes on this land without the addition of lime, but before it is again laid down in grass such land should be limed. Failure to do this was one of the main reasons for the very unsatisfactory results obtained when land was laid down to grass after being ploughed up during the last war.

Forms of Lime to Use and Price per Unit.—In most cases the form in which lime is applied is immaterial. It is largely a question of price and convenience in handling. Quicklime, in the form of ground lime or shell lime, ground limestone, shell sand, marl and waste lime from paper works, sugar beet factories, etc., are the principal forms of lime available.

These different forms of lime have all practically the same ultimate effect on the soil, but it must be remembered that approximately 35 cwt. of lime in the form of carbonate, such as ground limestone or dried paper works lime, will be required to give the same result as 20 cwt. of high-grade ground lime.

In making his selection the farmer should take into account the price per unit delivered on his farm. When lime is sold the analysis must be stated, and to obtain the unit price on the farm the farmer should divide the total cost per ton in pence by the percentage of calcium oxide which the sample contains, *e.g.*, Quicklime containing 90 per cent. calcium oxide (CaO) at £3 10s. per ton delivered on the farm costs 840d. $\div 90 = 9\frac{1}{3}$d. per unit. Ground limestone containing 45 per cent. calcium oxide at £2 per ton delivered on the farm costs 480d. $\div 45 = 10\frac{2}{3}$d. per unit, and is thus in this instance a dearer source of lime.

Indications of a lime deficiency are often to be seen in the crops and in the presence of certain weeds, but the safest way of

finding out whether a soil needs lime, and, if so, how much, is undoubtedly to have the soil tested. This is particularly desirable at present, not only from the point of view of getting lime applied where it is needed, but also of making sure that it is not being applied wastefully. An excess of lime can have harmful effects by lowering the availability to plants of some of the minor elements. Boron deficiency, for instance, which is responsible for diseases such as heart rot in sugar beet and raan in swedes, has been shown to be aggravated by an excess of lime.

Storage of Lime.—In normal times the farmer is accustomed to take delivery of lime at the time at which he is ready to apply it to the land, and little, if any, storage of lime needs to be done on the farm. On account of transport and other difficulties it is probable that during the war the farmer may have to take delivery of lime when he can get it, and not necessarily when he is ready for it. If this is done, there are two main possibilities to be considered : (*a*) storage of the lime until the farmer would normally be ready to apply it, and (*b*) application of the lime to the land out of season.

With regard to storage of lime on the farm the following are the main points to bear in mind. Lime in the form of carbonate, such as ground limestone, waste lime from paper works, etc., can, if necessary, be stored without danger and without undue risk of its becoming hard, with consequent difficulty of distribution. As in the storage of artificial fertilisers, precautions must, of course, be taken to keep the material dry. Ground lime takes up moisture very readily, and in so doing generates a large amount of heat, which may set fire to bags or other combustible material in contact with it. It will not, therefore, generally be possible to store ground lime on the farm, and this material should be used as soon as it is delivered. With shell lime which is being slaked before distribution, the question of storage under cover on the farm will not arise.

Time of Application of Lime.—Where storage of lime on the farm is impossible, it may be necessary to apply it out of season. In deciding when to apply lime the following considerations should be borne in mind :—

(1) Lime takes some time to become thoroughly incorporated in the soil and have its full effect.

(2) Oats, potatoes and turnips can withstand fairly acid conditions, and the greatest benefit (apart from the counteracting of finger-and-toe in turnips) is derived by sugar beet, barley, hay and pasture, and, to a considerable extent, wheat.

(3) If lime is to be applied to land just before ploughing, care should be taken to ensure that ploughing the following year is a little deeper, in order to bring the lime back to the surface layers of the soil.

(4) Lime applied to pasture which has deteriorated through acidity may bring about some improvement, but, in order to obtain the greatest benefit, the pasture has usually to be renewed.

On account of the risk of scab, it is not generally advisable to apply lime immediately before potatoes are grown, but, with this exception, lime may be applied usefully at practically any point in the rotation. One of the best times to apply it is to the ploughed stubble before the root crop is put in, or to the land which has been prepared for sowing out to grass. Lime may be applied at any season, and under present circumstances many farmers may find it necessary to depart from their usual practice, but, in the case of quicklime, care should be taken to avoid damage to growing crops.

Methods of Application.—In order to secure even distribution ground lime, ground limestone and dried waste lime are usually applied by means of a manure distributor. An improved method of distribution[1] is described in another article in this *Journal,* and is illustrated by the photographs between pp. 126 and 127. The main points in this method are :—(1) The lorry with the lime drives right on to the field, and unnecessary handling of the lime is done away with; (2) an ordinary manure distributor (the one illustrated is an International) is fitted with a special attachment to the lorry, and with a special hopper to permit of easy emptying of the bags of lime; (3) sheet iron discs fitted on the wheels and aprons, or sacking on the front and rear of the distributor, serve to reduce blowing of the lime by wind.

The amount of lime spread in this way in a day will naturally vary with the ground surface, the weather conditions and so on. Waste lime from paper works can be applied at the rate of anything up to 30 cwt. per acre at one sowing. Under good conditions, and working on grassland, it has been found possible to sow as much as 5 tons in an hour, and to keep this up for the greater part of the day.

Manuring.—The importance of adequate manuring for the maintenance of soil fertility cannot be too strongly emphasised. Crops, stock and all forms of produce sold off the farm remove plant food in considerable amounts. An illustration of this is given in the following table, where the figures represent amounts removed by different farm products :—

	Nitrogen (N) (lbs.)	Phosphate (P_2O_5) (lbs.)	Potash (K_2O) (lbs.)
1 ton oats (grain) -	36	15	11
1 ton potatoes -	8	3	12
1000 gallons milk -	54	23	20
10 cwt. bullock -	25	17	2

[1] Employed by Major James Keith, of Pitmedden.

There are also losses, particularly of nitrogen, in the drainage water, and, as might be expected, drainage losses are most severe on light textured soils. The amounts removed as produce or lost in drainage do not, however, represent accurately what must be returned to the soil, as other factors, such as the fixation of phosphates by the soil in forms unavailable to plants, have to be taken into account. It is clear that considerable amounts of plant food are removed every year, and that these should be replaced if fertility is to be maintained.

The losses are made up to some extent by the weathering of soil minerals and the action of micro-organisms, but the main losses have to be made good by ploughing in pasture and other crop residues, by the addition of farmyard manure and by the use of artificial fertilisers. These well-accepted principles can be followed easily in peace time, but war-time conditions give rise to problems such as the following:—

(1) Arable land has been increased at the expense of pasture. The necessity arises of manuring the increased arable acreage and obtaining the best possible returns from the remaining grassland.

(2) There must of necessity be a reduction in imported feeding-stuffs, and, consequently, some reduction in the numbers of stock. This will affect the quantity and quality of farmyard manure available, and the smaller supply will have to serve a larger acreage.

(3) The supplies of certain artificial fertilisers will be limited, and in many cases it will be necessary for farmers to take delivery of fertilisers before they require them. This raises the question of storage or, failing this, of the possibility of applying certain fertilisers to the land earlier than usual.

Supplies Available.—With the exception of potash, the position with regard to the supplies of artificial fertilisers is, on the whole, satisfactory. Nitrogenous manures are largely home-produced and, unless circumstances alter, the amount available, particularly of sulphate of ammonia, should be ample. Farmers, however, will not be able to obtain the choice of different forms of nitrogenous manures to which they have been accustomed.

At present the supply of phosphatic manures is also satisfactory. Large quantities of basic slag are produced in this country, and so far there has been no shortage of superphosphate. The supplies of ground mineral phosphate are likely to be largely required for the manufacture of superphosphate, and for use in compound fertilisers. Bone flour is also likely to be required chiefly for mixing in compounds.

Potassic fertilisers are very scarce, as the normal supplies are

cut off, but limited amounts, chiefly of muriate, are available for certain crops.

There are at present sufficient supplies of compound fertilisers, but the range of varieties has been curtailed, and potash will have to be omitted from most of them.

Every endeavour should be made to compost organic waste material in order to augment the supplies of farmyard manure. Use should also be made of seaweed, where it can be obtained, of town refuse and of slaughterhouse waste which cannot be used as a feeding-stuff.

Time of Application of Fertilisers.—Farmers have been urged by the Government to take delivery of manures whenever supplies are available, possibly long before they are required, and this raises the questions of time of application or storage on the farm

(1) *Nitrogenous Fertilisers.*—These are all rapid in their action, and are not readily fixed or held in the soil. Unless they are applied at a time when plants are growing or starting to grow, there may be a considerable loss. This means that artificial forms of nitrogen, either in the form of straight fertilisers or as constituents of a mixture, will generally have to be applied either during early spring or some time during the growing season. Supplies of these delivered out of season on the farm will therefore have to be stored until the crop is ready for them.

(2) *Phosphatic Fertilisers.*—Unlike nitrogenous fertilisers, there is for practical purposes little danger of phosphates being washed out of the soil, and where there is a difficulty in storing manures on the farm the possibility of applying phosphates during the autumn or winter months should be considered. It is, of course, common practice to apply basic slag, mineral phosphate or bones during the autumn or winter. Except for autumn or winter sown crops and for grassland, superphosphate is, however, generally applied in the spring. From the point of view of storage, it would undoubtedly be an advantage in many cases if superphosphate were applied at some season other than spring, but this raises the question whether the efficiency of superphosphate will be reduced by applying it before the plants are ready to use it. Unfortunately there does not appear to be any direct experimental evidence on this question, but the following are some of the factors which have a bearing on it. Although the phosphate in superphosphate is soluble in water, there is no danger of its being washed out of the soil to any appreciable extent, except possibly in very light, acid soils in very wet districts. On the contrary, a reduction in the efficiency of superphosphate is more likely to arise as a result of its conversion in the soil into forms of low solubility, which may be largely unavailable to crops. This is most likely to happen in soils which are very acid and low in lime, particularly if they

are at the same time very low in phosphate. It is also more likely to happen in heavy than in light soils. In soils which are fairly well supplied with lime the loss of efficiency is likely to be small, and will probably be compensated by an increase in residual effect. It is a well-established fact, proved by numerous field tests, that superphosphate has a marked residual value, and its effects can be seen for a number of years after application.

It may be concluded, therefore, that superphosphate may be applied in the autumn or winter without risk of serious loss of efficiency, particularly if the soil is not too low in lime or extremely deficient in phosphate. Where possible, and especially in doubtful cases, it is advisable that the soil be tested. Another important factor to be considered is, of course, the crop to be grown. On grassland intended either for hay or for grazing superphosphate could quite well be applied any time during the autumn, winter or spring. For cereal crops and for root crops, other than potatoes possibly, the risk of loss of efficiency following autumn or winter application should likewise not be great, provided the superphosphate is applied to the land after ploughing. If direct application of superphosphate to the ploughed surface will enable early delivery to be taken, particularly where there is a lack of storage facilities, it would appear to be well worth consideration during the war.

(3) *Potassic Fertilisers.*—Although potash manures are water soluble, experiments show that, except in light, sandy soils in districts of heavy rainfall, they are not readily washed out of the soil. Like the phosphatic fertilisers, it may be concluded that in most cases potassic fertilisers could also be applied to the land out of season, if it is a question of obviating storage difficulties.

(4) *Compound Fertilisers.*—As these practically all contain nitrogen, application to the land will have to be made at the usual time.

Storage of Fertilisers.—Where manures cannot be applied directly to the land on delivery to the farm, an attempt should be made to store them in such a way that they will not set hard and thereby become a source of trouble at sowing time. The first essential in storing manures is to keep them absolutely dry, and most farmers are now aware of the precautions to be taken to ensure this. There should, for instance, be no possibility of rain or water from other sources reaching the bags; care should be taken to see that the bags rest on wood and not on bare ground. Concrete and iron, too, should be avoided, as their cold surfaces cause condensation of atmospheric moisture. Protection of the bags with straw is an added advantage. If no building of any kind is available on the farm for the storage of manure, another possibility which has been adopted by various farmers is to build the bags of fertiliser into a stack of straw. With a good founda-

tion, and with straw between successive layers of bags, manures appear to keep in good condition, and this method is worth consideration when other facilities are lacking.

Manures vary in their power of absorbing moisture. Nitrate of lime, nitro chalk, nitrate of soda, kainit and agricultural salt all take up moisture very readily, are thus liable to set badly, and are consequently the most difficult to store safely. The various phosphates, on the other hand, are much less liable to take up moisture and, if reasonable precautions are taken, store well.

MANURING OF VARIOUS CROPS.—*Phosphate.*—There is a widespread deficiency in phosphate in our Scottish soils. This applies even to the land in regular cultivation, and is particularly true of the neglected grassland that has been broken up to meet war-time requirements. At the present time phosphate is available on the market principally as superphosphate, either by itself or in compound fertilisers, and as basic slag.

Experimental evidence shows that for the majority of crops on most soils there is little to choose between superphosphate and high soluble basic slag. (A high soluble slag is one in which 80 per cent. or more of the phosphate is guaranteed to be soluble in 2 per cent. citric acid.) What little differences are found are generally in favour of superphosphate, especially in the first year, but the residual effect of high soluble slag is sometimes found to be slightly greater. It must be emphasised that a low soluble slag (40 per cent. or less of the phosphate soluble in citric acid) is much inferior to superphosphate and high soluble slag, both in the first year and in subsequent years. For grassland high soluble slag is generally preferred, whilst for potatoes, which prefer a quick-acting soluble fertiliser, superphosphate is generally better. On acid or sour soils, basic slag has the advantage of helping, to some extent, to counteract the acidity, and it is less readily converted in such soils into insoluble forms which are of less value to the plant. The lime value of 3 cwt. high soluble slag is roughly equal to 2 cwt. of carbonate of lime, whilst low soluble slag has about half this value. Contrary to what is often stated, superphosphate also tends to decrease soil acidity, but not to such a great extent as slag.

It may be concluded, therefore, that except for potatoes, where superphosphate is probably preferable, and on acid soils and grassland, where slag is probably better, there is for practical purposes little difference between superphosphate and high soluble slag.

Nitrogen.—If land is well supplied with phosphate, nitrogenous fertilisers can be used with far greater effectiveness for the purpose of increasing yield without decreasing quality. The dress-

ings of nitrogen to be given in artificial form will depend, amongst other things, on the amount and quality of the dung available, and on the crop. Where dung is scarce or of poor quality, nitrogenous dressings should be increased. It is with the leafy green crops such as kale that the biggest returns will be obtained from nitrogenous fertilisers. In manuring trials with kale it is generally found that dressings of the order of 4 cwt. or even more sulphate of ammonia per acre can profitably be applied. Most root crops also will respond to fairly heavy dressings of nitrogenous manures; with cereals more care has to be exercised in their use. Excess of nitrogen will increase the risk of lodging and, especially with barley, quantity may be obtained at the expense of quality, if unduly heavy dressings are given. Similarly, for a crop such as flax, nitrogen must be carefully applied, since an excess will reduce the quality of the fibre, and with this crop nitrogen is generally best applied as a top dressing after weeding, if the appearance of the crop indicates its desirability.

On most farms there will, during the war, be less land available for grazing purposes, and what grassland there is must be made to yield as much as possible. The application of nitrogen in artificial form provides a ready means of increasing the bulk of pasture at whatever time it is most required during the grazing season. The source of nitrogen most likely to be available for this purpose is sulphate of ammonia, and top dressings of this fertiliser can be used to promote growth of pasture for hay, grass silage, grazing, etc., according to requirements. Where it is proposed to use heavy dressings of sulphate of ammonia, it is very important to keep up the lime and phosphate supplies. On grassland, for instance, unless this is done the growth of grasses will be promoted at the expense of clovers.

Potash.—The crops which will have first call on the limited supply of potash available are potatoes, market garden crops, sugar beet and flax. Other crops, such as turnips and swedes, which also have a high potash requirement, will have to depend on the reserves in the soil and on crop residues and farmyard manure. On land which is being ploughed from ley, or which has been dunged in rotation, there is generally sufficient potash to meet the immediate needs of most crops.

Minor Plant Foods.—Crop failures sometimes occur as a result of a deficiency in substances such as boron, magnesium, manganese, etc., which require to be present in the soil only in small amounts. If there is any reason to suspect such a deficiency the farmer should immediately consult his local County Organiser.

Soil Testing.—The aim at the present time must be to obtain the highest possible yields. This can best be done by adequate

liming and manuring, but it is highly important that manures should not be wasted. Heavy nitrogenous manuring and the shortage of potash will lead to a certain depletion of the reserves in the soil, but in war time the cashing of reserves is unavoidable. It is, however, particularly important to restore these reserves if the land is again to be laid down in grass after the war. To get the most out of the soil it is desirable to obtain as much information as possible about it, and farmers are consequently advised to have their soils tested. Any farmer in Scotland can have this done free of charge. A soil-testing service is provided by the Scottish Colleges of Agriculture and by the Macaulay Institute for Soil Research at Aberdeen. Any farmer who wishes to have his soil tested should get in touch with his local county organiser or executive officer, or communicate direct with the above bodies, the addresses of which are as follows:—

For farmers in North of Scotland College area: Macaulay Institute, Craigiebuckler, Aberdeen.

For farmers in East of Scotland College area: 13 George Square, Edinburgh 8.

For farmers in West of Scotland College area: 6 Blythswood Square, Glasgow, C.2.

Summary.—(1) There is a widespread need for lime and phosphate in Scottish soils. This applies to land that has been regularly cultivated, but is most acute in neglected grassland now being ploughed.

(2) Lime may be applied usefully at any point in the rotation except, possibly, before potatoes, but if it is applied just before ploughing the next ploughing should be a little deeper in order to bring it back to the surface.

(3) To increase food production, manuring should be increased as far as supplies permit; this applies particularly to the application of additional nitrogenous dressings to all crops, but especially to leafy green crops and grassland,

(4) To compensate for a shortage of farmyard manure, additional dressings of artificial fertilisers, especially nitrogen, should be applied.

(5) Where heavy dressings of nitrogen are given in the form of sulphate of ammonia it is particularly important to have sufficient lime and phosphate in the soil.

(6) Nitrogenous fertilisers should be applied during the growing season, but other fertilisers, including superphosphate, may, if there is difficulty in regard to storage, be applied at any time.

(7) Reference is made to the precautions to be taken for the satisfactory storage of manures on the farm.
(8) In many soils reserves of lime and manure will be depleted by war-time cropping. It is important that these should be restored, particularly before land is laid down to pasture.
(9) Farmers are recommended to take advantage of the soil-testing facilities which are offered free of charge.

WAR ON SHEEP DISEASES.

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Animal Diseases Research Association.

DURING the last twenty years organised research into the major problems of animal disease has been actively prosecuted. As a result, the nature of a number of the major animal scourges, especially those affecting the sheep, which in the past have been the cause of large economic loss, has been elucidated, and specific means for their prevention have been, or are in the process of being, evolved. It is proposed briefly to discuss here some of the more important of these diseases.

Braxy.—Braxy, or "sickness," commonly attacks hoggs, especially those in thriving condition. The disease is confined principally to hill grazings, and the majority of cases occur in the autumn and winter. Climatic conditions appear to play some part in the production of the disease, and the association of the occurrence of braxy with hoar-frost is well recognised.

The course of the affection is so short that affected sheep are usually found dead, but, if seen during the short period of observable illness, the animal shows signs of abdominal pain, considerable swelling of the abdomen and the presence of frothy matter about the mouth and nostrils.

On post-mortem examination an inflammatory patch on the lining membrane of the fourth stomach is usually evident, and signs of extensive inflammation may be occasionally present in the stomach and small intestines. An excessive quantity of yellowish or reddish coloured fluid may be found in the body cavity. The carcase putrefies rapidly and becomes distended with gas.

The disease is due to the ingestion of a microbe known as *Clostridium septique,* and it has been found that infection can be prevented by vaccine prepared from an artificial growth of this microbe, inactivated by formalin.

When the vaccine is injected under the skin the sheep develops a protective immunity about fourteen days after the inoculation. The vaccination, therefore, should be carried out shortly before the commencement of the seasonal occurrence of the disease. On farms where the disease is virulent it may be advisable to vaccinate twice, allowing an interval of fourteen days to elapse between the inoculations.

Louping-ill.—Louping-ill, or " trembling," has been recognised for the last one hundred and fifty years as a source of serious losses in sheep stock.

The disease appears to be peculiar in its occurrence to Scotland and Northern England. In Scotland it is prevalent throughout the North-western and Central Highlands, and in the Southern Uplands from South Ayrshire to the Tweed.

It was early recognised that louping-ill occurred only on land which was infested with the sheep-tick, *Ixodes ricinus,* and this, in conjunction with the fact that its seasonal incidence bore relationship to the periods of maximum tick activity—April, May, early June and again in September—led to the assumption that the tick acted as a carrier of the disease.

The farm animals susceptible to the disease are sheep, cattle and possibly pigs..

Cause.—In the course of prolonged investigations many microbes have been suspected as the cause of louping-ill, but research has proved that the disease is produced by an ultra-microscopic, ultra-filtrable virus, that is a virus so minute that it cannot be rendered visible by the most powerful microscope, and is capable of being filtered through unglazed porcelain.

It has also been proved that the virus is transmitted from sheep to sheep through the medium of the tick, which in its larval or nymphal stage acquires virus by sucking blood from an affected sheep and then transmits it to a healthy sheep, which it bites in its subsequent nymphal or adult stage.

Symptoms.—In sheep exposed to natural conditions of infection a period of six to eighteen days may elapse between the time of infection and the appearance of the first signs of illness. The early stage of the disease is characterised by dullness and fever, and during this stage the virus multiplies in the blood. At about the fifth day of infection, however, the virus may attack the cells of the central nervous system, and this is followed by symptoms of excitability, tremor—especially of the head—muscular spasms and irregularity of gait. Balance may be affected, and the sheep become unable to stand. In the later stages paralysis of one or more limbs or of the hindquarters may develop.

The nervous symptoms differ markedly in individual cases, and

frequently spontaneous recovery occurs during the early phase without affection of the nervous system.

Treatment and Prevention.—No specific curative treatment is known, but, if affected sheep are kept in sheltered, quiet surroundings and carefully nursed, the chance of recovery is definitely increased.

The disease can be effectively prevented by the use of vaccine prepared from the virus, and by this means the incidence of the disease on many farms has been reduced to a negligible figure. On farms on which louping-ill vaccination has not previously been practised it is advised to vaccinate the whole sheep stock (with the possible exception of the lambs) at least once. In succeeding years one of the following alternatives should be followed :—

(*a*) The hoggs should be vaccinated a fortnight before they return from wintering, or at the beginning of March if they are wintered at home. The gimmers should also be vaccinated at the beginning of March.

(*b*) In order to prevent the losses from louping-ill which, on some farms, occur in the autumn, it has been found beneficial to vaccinate in August the ewe lambs kept for stock, and these again as hoggs in the spring.

Since the vaccination of young lambs is attended by some degree of risk, it is not generally recommended. Research is in progress for the purpose of evolving a hyper-immune serum which, while safe for use in young lambs, may afford adequate protection against the disease.

General preventive measures include the control of ticks by dipping and other means.

Tick-borne Fever.—Tick-borne fever had long remained unrecognised as a specific disease of sheep because, being tick-borne, it has the same geographical distribution and the same periods of seasonal occurrence as louping-ill, with which it was consequently confused.

Cause.—The cause of tick-borne fever is now recognised as a minute microscopic parasite which can be demonstrated in certain of the white blood corpuscles. As in the case of louping-ill, the disease is transmitted by the bites of infected larval and nymphal ticks. The blood of affected sheep remains infective for prolonged periods; consequently the great majority of ticks on infected pastures are likely to harbour the causal microbe, and thus practically every sheep on such pastures becomes the subject of the disease.

Symptoms.—After an incubative period of about one week symptoms of dullness develop, and these are accompanied by a high degree of fever and considerable loss of physical condition. The

febrile symptoms are irregular and may be prolonged, but commonly subside after a period of about ten days. They are, however, usually succeeded by several recurrences. The sheep eventually develop an immunity or a tolerance to the disease, and so possess an "acclimatisation value."

The economic importance of tick-borne fever largely consists in its reducing the bodily condition and the general health of the flock, and in its rendering the infected sheep, particularly lambs, more susceptible to other diseases.

No satisfactory method of prevention by means of vaccines or sera has yet been discovered.

Pyaemia in Lambs.—On many tick-infested farms lambs of about one month old suffer from pyaemic infections, characterised by abscess formation in various parts of the body and septic inflammation of the joints. The cause of this condition is known to be due to various strains of a microbe (*Staphylococcus aureus*). It is believed that infection occurs through the medium of tick-bite, and although no specific remedy is at present available, methods of preventive vaccination are now under investigation. It is known that many lambs suffer simultaneously from louping-ill, tick-borne fever and pyaemic infections, and therefore, if for no other reason, the problem of tick control is an urgent one.

Lamb Dysentery.—Lamb dysentery is a contagious inflammation of the bowel affecting young lambs a few days old. The disease has probably occurred for very many years in localised areas, particularly in the border counties, but it has markedly increased in virulence and extent, especially during the last twenty years.

Cause.—The causal organism is a specific variant of *Clostridium welchii*, and infection appears to occur only by the ingestion of the specific microbes. The disease usually occurs on affected farms in low incidence for two or three years, but later the incidence markedly increases, and upon occasion 50 per cent. of the lambs may be lost. In infected flocks usually only a few lambs are affected at the commencement of the lambing season, but, as this continues, the disease appears in more virulent form and in much higher incidence. The pastures become contaminated from the excrement of the affected lambs, and adult sheep may act as bacilli carriers.

Symptoms.—In acute cases the lamb is dull; lags behind the flock; refuses to suck; the abdominal wall is tense and painful on pressure, and diarrhoea is invariably present. The excreta, which are yellow at first, later become chocolate coloured, and may contain unaltered blood. The disease almost invariably terminates fatally after a course of one to three days.

Post-mortem Findings.—In very acute cases inflammation is present in greater or less degree and extent throughout the bowel, and may be associated with necrotic ulceration of the lining membrane. In less acute cases ulceration of both the small and large bowel is more pronounced, and ulcers measuring up to one-quarter inch in diameter, or large necrotic patches may be present.

Prevention.—No method of cure is known, but two specific preventive measures are employed :—

1. *Vaccination of the Ewe.*—In this method the ewe is vaccinated shortly before the rams are put out, and again about ten days before lambing. By this means the ewe obtains an active immunity which, however, is not transmitted to the developing foetus, indeed the lamb at birth is readily susceptible to the disease. Immune bodies (anti-bodies) are, however, highly concentrated in the first milk of the ewe, and the lamb obtains a passive immunity so soon as it begins to suck. The immune bodies continue to be absorbed by the lamb for at least the first four days after birth. There is evidence that in succeeding years the ewe requires to be vaccinated only once, preferably just previous to lambing.

2. *Serum Injection of the Lamb.*—A hyper-immune serum is injected subcutaneously into the newly born lamb as soon after birth as possible. By this means the lamb receives a passive immunity which renders it immune for one or two weeks, and thus tides it over the period of infection.

Each of these methods affords adequate protection against lamb dysentery.

On hill farms the vaccination of the ewe is largely practised, since the conditions under which lambing is carried out render difficult, if not impossible, the satisfactory injection of lambs with serum shortly after their birth.

Pulpy Kidney Disease.—Pulpy kidney disease usually affects lambs in thriving condition when they are a few weeks old (less frequently from three weeks to three months old). The course is very short, and a lamb appearing in perfect health in the evening may be found dead in the morning.

Cause.—The disease is due to a microbe, *Clostridium welchii* (type D), allied to that which causes lamb dysentery, and which is capable of rapidly proliferating and producing a toxin in the contents of the bowel. The term pulpy kidney disease is derived from the fact that the kidneys rapidly disintegrate after death.

The disease is frequently associated with the " flush " of grass in the spring. The milk secretion of the ewe increases at this time, and it is suspected that the increased intake of the milk by the lambs predisposes them to attack. It has also been observed that when the ewes are transferred from relatively poor to richer

pastures this also appears to predispose to the occurrence of pulpy kidney disease in the lambs.

The occurrence of sudden deaths in thriving lambs of a few weeks old—especially when louping-ill and pyaemia can be excluded—should raise very strong suspicions that such deaths are due to pulpy kidney disease. The disease can be definitely diagnosed by laboratory test.

Prevention.—It has been found that the use in young lambs of lamb dysentery anti-serum appears to reduce the incidence of pulpy kidney disease. A specific pulpy kidney anti-serum has also been prepared, and while this affords adequate protection, the flockmaster is frequently unable to decide whether the use of such a serum is an economic measure, since the incidence of the disease in a given flock varies very markedly from year to year, and when the disease makes its appearance the flockmaster does not know whether his losses may be serious or merely confined to a few lambs.

Pine.—The term pine has been applied to a number of disease conditions in sheep and cattle characterised by progressive debility. It had been shown that a disease of sheep and young cattle which occurred in the Inner Hebrides was closely similar to, if not identical with, a disease in New Zealand named "bush sickness," in that, apart from other considerations, both conditions could be prevented and cured by the administration of crude iron compounds. Later investigations by Australasian workers afforded evidence that "bush sickness" was in fact due to a deficiency of cobalt. It may reasonably be inferred that the beneficial effects of iron compounds are due to the fact that they contain minute quantities of cobalt as an impurity. Experimental evidence has now been obtained that pine, in so far at least as it affects certain parts of Scotland, can be treated with complete success by the administration of cobalt alone. Further experimental evidence has indicated that the addition of cobalt to phosphatic manures will so raise the cobalt content of soil and pasture in pining areas that such manurial treatment can effectively prevent the occurrence of pine. It is conceivable, therefore, that large tracts of country in which pining has been prevalent for long periods of time can be converted into healthy grazings.

Solway Pine.—A peculiar form of pine occurs in the granite areas in the region of the Solway Firth. This appears to be distinct from that form of pine described above. There is some evidence that the disease is associated with a deficiency of magnesium and potassium, and experiments are now in progress to determine the value of feeding mixtures containing these minerals in high concentration.

Lambing Sickness.—For a number of years it has been known

that milk fever in the cow is due to an acute fall in the concentration of blood calcium, and that the injection of assimilable calcium salts effects a rapid and complete recovery from this disease. The condition known as lambing sickness in the ewe has been shown to be closely allied in its nature and causation to milk fever in the cow.

As distinct from milk fever, however, in which the attack usually manifests itself within the first three days after calving, lambing sickness not infrequently appears shortly before lambing, especially if the ewe is subjected to undue exertion and fatigue; it is also commonly encountered in ewes with young lambs at foot. The attack is usually sudden, and is marked by excitement and convulsive movements, followed by coma.

The application of calcium therapy by a veterinary practitioner almost invariably results in rapid recovery.

Pregnancy Toxaemia.—Lambing sickness was formerly confused with another condition known as pregnancy toxaemia. This disease occurs during the last few weeks of pregnancy, and is confined to ewes carrying twin or triplet lambs.

The symptoms are those of dullness, uncertain, even staggering gait, the bowel movements are sluggish and may be entirely suspended. In the course of a few days the ewe is unable to rise, and finally becomes progressively comatose; death usually results in the course of one to six days.

In pregnancy toxaemia—as distinct from lambing sickness—the blood calcium content is relatively normal, and no curative treatment is at present known; it has been recognised, however, that ewes which lamb, or abort, during the course of the illness make a rapid recovery.

As a preventive treatment it has been recommended that during the last few weeks of pregnancy, the ewes should be exercised by driving them slowly but continuously for a distance of about a mile each day.

While it is true that, as a result of organised research, several diseases affecting livestock have been shown to be caused by various specific factors, it may be questioned whether the veterinarian has not become too wholly engrossed in elucidating the *immediate* cause of animal disease, and whether he should not concern himself also in studying the fundamental causal factors of the problems that confront him. Such fundamental contributory causes of diseases in general are at present difficult to define, but they may be found to be associated with the marked deterioration of the quality of hill pastures which so long has been proceeding unchecked.

The question of the improvement of hill pasture in general sheep husbandry is now receiving earnest attention, and with those engaged on the problem the veterinarian may usefully co-operate.

WAR ON PLANT DISEASES.

C. E. Foister, B.A., Ph.D.

With the advent of war our home-produced food supplies have become of paramount importance. Before the war we were producing barely one-third of our annual food consumption, and the agricultural and horticultural community have therefore a gigantic task to produce extra food equal in amount but not in kind to that previously imported. Attention is now directed mainly to the staple food crops, such as potatoes, cereals, roots, sugar beet and brassicas. Tomatoes and raspberries are still important, the former particularly so in view of the loss of the chief sources of imported tomatoes, which in 1938-9 much exceeded home-grown produce. The market-garden trade in fresh vegetables is also in need of augmentation.

Scotland must therefore make every effort to safeguard its crops by every possible means. In peace time the control of diseases was sometimes considered inexpedient, not because there was any doubt as to the efficiency of the methods, but because it was considered that financial returns were not improved thereby. Now, however, maximum food production takes first place, and the following notes are given to draw attention to the great need of safeguarding our crops, and of using such methods of control as have been found to be both efficient and practical.

Losses Caused by Diseases.—To demonstrate the importance of plant diseases it may be worth while to examine a few instances of the losses they cause in Scotland. It must be admitted that such estimates are not generally very exact, as they often apply to restricted localities, but in view of available statistics published and otherwise, a conservative estimate can be given. Potato Blight will cause losses ranging from 0 to 50 per cent. or more, and an average annual loss will approximate to 10 per cent. of the crop in Scotland, or 92,000 tons. Classification of the health of crops throughout Scotland would indicate that 10 per cent. loss may be occasioned annually by virus infection. Thus these two diseases alone rob the country of approximately 180,000 tons of potential potato crop. In view of the fact that there is generally a surplus of potatoes, except when disease is severe, this would indicate that some 21,500 acres could be devoted to other crops or other important agricultural purposes. The oat crop in Scotland was 633,000 tons in 1938, but if such a disease as Stripe and Pre-emergence Blight, due to *Helminthosporium Avenac*, were allowed to develop unchecked, as it was years ago, we could count on a loss of crop of between 40,000 and 63,000 tons, or, alternatively, use an extra 8,500 tons of seed oats to offset this loss. Similar examples could be given, but one will suffice. The tomato, because

of its production under glass, is particularly liable to serious diseases, and, although these are all amenable to control, should they be allowed to develop unchecked the crop suffers severe damage. Often tomato houses have to be replanted once or even twice. The output of this crop was over 6,000 tons in 1935, and the writer considers, from evidence of reports received from all over Scotland, that it could be increased by 15 per cent. if diseases were more rigorously eliminated. Not all crops suffer so severely from diseases, nor do all diseases cause such direct loss, but these instances should suffice to support the contention that now, at least, attempts should be made to combat all serious diseases.

Seed Treatment.—A number of diseases are transmitted with the seed. In some instances the causal fungus enters and permeates the seed structure, in which case seed dressing affords no control. Loose Smut of Wheat is one such disease, and for this the only control is the hot water treatment, where the seed is immersed for about four hours in cold or luke warm water, followed by a plunge in water at 120° F. for five minutes, and finally for ten minutes in water kept constant at 125° F. In the case of Bunt of Wheat, Loose and Covered Smuts of Oats, Covered Smut of Barley and Stripe of Oats, the causal fungi are carried on the seed coats, and are killed by treatment with the organic mercurial dusts which have been widely used for some years now, particularly to control Stripe of Oats. The usual dressing is 2 ozs. of the dust per bushel of grain. An additional way in which such dusts are beneficial is by reducing the chances of attack by soil-inhabiting fungi which, under certain seasonal and soil conditions, may infect the developing seedlings, thereby causing poor brairds or foot rots. This latter fact may explain to some degree those cases where Stripe of Oats was not serious, and yet a dressing with the organic mercurial dusts gave such increase of crop as to induce farmers to believe that the benefit was derived from a fertiliser in the dust, which is not the case. There is evidence that even now not enough farmers practise seed treatment or demand such treated seed from the merchants. Other seed-borne diseases which can be similarly controlled are Blackleg of Beet and Mangold and Foot Rot and Pod Canker of Peas. With the increase in the number of allotments and private gardens, all of which grow some peas, this disease has been noted very commonly both in new and long-established plots. The writer would suggest that treatment of all pea seed by the wholesale merchant before distribution would go a long way to reduce the losses caused by this disease. Dry Rot of Swedes, due to *Phoma lingam,* has been shown to be seed-borne, and it has been demonstrated that epidemics in the field can be traced to such infection. Unfortunately the seed is delicate, and while some degree of control has been

obtained by certain seed treatments, a thoroughly satisfactory method has yet to be devised.

Virus Diseases: Selection, Roguing and Breeding.—As already indicated, virus diseases of potatoes can be a cause of very considerable loss. While a great advance has been made in the last twenty years in improving the general health of this crop, mainly by the introduction of an inspection and certification scheme, there is sufficient virus infection in existence and still being perpetuated to suggest that farmers and others should take still further steps to eliminate these diseases. Leaf Roll and certain Mosaic diseases are transmitted from plant to plant by greenfly. This insect breeds and becomes distributed more readily in localities relatively free from strong winds, and also breeds to a large extent in brassica crops. Hence it is not surprising that heavily infected crops are commonly found near large towns, where brassicas are more densely cultivated, whereas the healthiest crops are frequently situated in the hilly districts. Plants once infected are incurable, and the produce is always infected. To control these diseases the crops must be regularly inspected for plants showing infection, these being removed at once with their produce—preferably with the plants on each side, as they would be the first to become infected therefrom—and fed to pigs or burned. This practice of roguing can be supplemented by careful selection of plants known to be very healthy, and growing the produce of these in areas isolated from all commercial crops which are liable to be infected. The solution of this problem lies in breeding varieties immune from certain virus diseases, and some progress has already been made in this direction. Further particulars concerning potato viruses, and the method of improvement by inspection and certification, can be obtained in the Department of Agriculture's Miscellaneous Publication No. 3.

Similarly, tomatoes suffer considerably from various virus diseases. At one time Tobacco Mosaic and Streak were very widely distributed, and very serious losses occurred, but in recent years these have become less serious since growers have become aware of the importance of careful selection of seed crops, of careful roguing out of infected plants as early in the season as possible, and the avoidance of undue handling of the crop. The name Tobacco Mosaic includes a wide range of strains, most of which are very readily transmissible by contact. Hence dissemination is effected by handling an infected leaf or stem and then handling a healthy plant. Recently it has been proved that the juice from cigarettes expressed on to fingers in the process of smoking has transmitted this virus disease to tomato plants. It is a good rule to forbid smoking or chewing of tobacco in tomato houses. Other virus diseases are transmitted by insects. The worst of

these tomato diseases in Scotland is Spotted Wilt, and the insect that transmits it is the Onion Thrip (*Thrips tabaci*). Attention tc the control of all insect pests in glasshouses is therefore a sound practice. Spotted Wilt is particularly dangerous since it can also infect nearly 100 ornamental and other plants, and is carried from one tomato crop to another by Chrysanthemums, Dahlias, Begonias, Amaryllis and others brought into the houses before these have been thoroughly cleared of tomatoes, cleaned and fumigated.

Insect Vectors.—It should again be emphasised that many insects are responsible for the spread of certain virus diseases. The greenfly, *Myzus persicae,* is one of the most important in this respect, and is recorded as transmitting 21 virus diseases. Some forty other insects are known to transmit virus diseases, and of the more outstanding here are the Potato Aphides, the Onion Thrip (damage on tomato mostly), Black Currant Gall Mite, (transmits Reversion), Raspberry Aphis, Strawberry Aphis and the Mealy Cabbage Aphis. Most of these have a wide host range. For example, the Potato and Rose Aphis has a range of 41 hosts, the Green Potato Aphis feeds practically on any plant. Hence virus diseases are not readily kept in check unless due regard is paid to every possible host plant on which a vector may be sheltering. Insects cannot readily be kept under control in the field, but under glass there is a reasonable chance of doing so by fumigation and by spraying.

Soil-borne Diseases.—It is not sufficiently realised by growers that the soil is a perfect reservoir of plant organisms, some of which are parasites which remain dormant waiting for the right host plant to appear, while others live in the soil, adding to its fertility by their activity. The various forms of animal and plant life in the soil in normal conditions are well balanced, but this relationship is bound up with the physical conditions of the soil. Matters go wrong when man alters the balance by growing crops in close succession, by adding unusual quantities of the richer nitrogenous manures and by forcing the plants growing therein. Parasitic organisms then find suitable conditions under which they can attack our economic crops. Many important plant diseases are caused by soil-inhabiting fungi. All the potato tuber diseases except Blight, namely Corky and Common Scab, Skin Spot, Black Scurf, Dry Rot, Gangrene, etc., come from the soil; Finger-and-Toe is also soil-borne, as is the Take-all disease of Wheat. All those fungi causing root and foot rots of tomato (*Colletotrichum, Phytophthoras,* and *Pythiums*), and the various wilt fungi, such as *Verticillium* and *Fusarium,* are inhabitants of soils. In glasshouses we have a reasonably sure remedy in the use of steam sterilisation or formaldehyde solutions. Most

up-to-date large glasshouses are steam sterilised, and no better, surer method of control could be devised. But there is one danger in this practice: if only a trace of disease is introduced after steam sterilising, it will spread at an alarming rate and cause more serious damage than if the soil had not been treated. This is due to the fact that steaming eliminates almost all forms of life, so that there is no competition with the disease organism when it is introduced. Formaldehyde treatment sometimes gives disappointing results. This may be traced to incomplete treatment of portions of the soil or to using too weak a solution. While the lethal action of formalin is best at low concentrations, it is advisable to use less water and a higher strength than to soak the soil with too much water. A good application on wet soils is 15 gallons of 1 in 49, and on dry soils 30 gallons of 1 in 99, per three square yards of soil 1 foot deep.

With field and garden crops, however, we cannot apply methods possible in glasshouses. Here rotation of crops is essential to effect even a partial control. Finger-and-Toe and Wart Disease organisms will remain in soils in a viable condition for many years, hence ground that has been allowed to become heavily contaminated with such diseases cannot be freed by ordinary rotations. Long rotations will help to reduce the incidence of many diseases. In the case of Finger-and-Toe lime must be applied and incorporated to some extent with the soil, and not left, as is usual for other purposes, on the surface. The potato tuber diseases are not all equally important and vary with the variety involved. For example Skin Spot is serious on King Edward and Kerr's Pink, because with these varieties the eyes may be attacked and killed, leading to blanks in the field when planted. Dry Rot is important chiefly on the early and second early varieties, such as Ninetyfold, Sharpe's Express, May Queen, Arran Pilot, Catriona, but also on Doon Star and Dunbar Standard. This potato tuber disease, however, is to a certain extent preventable, apart from rotation, by *avoidance of wounding and bruising* in the various processes between lifting and marketing. The first step is to eliminate Blight by spraying with Bordeaux or Burgundy Mixture, or one of the accepted substitutes which have come on the market in recent years. This should be followed by burning down the haulms some time before lifting with a strong copper sulphate solution, or with sulphuric acid of 10-20 per cent. strength at the rate of 100 gallons per acre. To prevent Dry Rot and Skin Spot developing on "seed" potatoes, tubers can be dipped, on the same day as lifted, for one minute in an organic mercurial solution, various makes of which are on the market; in addition this treatment kills any Blight spores which might fall on to the tubers at lifting time. Tubers must be well dried before storage.

Hygiene.—In market gardens, allotments and fruit plantations disease can be avoided to some extent by hygienic precautions, such as burning all diseased material instead of throwing it on the rubbish heap; by cleaning all equipment, houses, sheds; by treatment of all pruning wounds and the application of winter washes to fruit trees, etc. Even on the farm something can be done to reduce sources of disease. Diseased potatoes should be burned in heaps on the field, and diseased tubers should be boiled before being fed to pigs.

Allotments.—The intensified campaign for the growing of vegetables has resulted in a very large increase of allotments all over the country. Owing to the breaking-in of new land and the inexperience of many allotment holders, diseases and pests have caused considerable havoc this past season, with disheartening results. However, allotment holders need not despair for the future. One of the cardinal factors in crop production is good husbandry. If the soil is well prepared, well drained and plenty of humus is added in the form of dung or compost, crops have a better chance to grow well. Rotation should be practised on allotments as much as possible. Some artificial manuring is an advantage, as balanced feeding tends to confer a degree of hardiness to crops; heavy nitrogenous manures favour large sappy growth, which is commonly more susceptible to disease. Good seed should always be obtained. It is better to pay a little more and get seed which is first-class. Allotment holders should particularly note that they are not advised to save their own potato crops for seed purposes. So often potato crops in allotments have leaf roll or mosaic, and the saving of seed would only perpetuate the trouble in the following season. Even if a crop looks healthy it may have become infected late in the season by greenfly which have fed on a neighbouring infected crop, though no symptoms show up to the time of lifting.

This short article necessarily covers only a few aspects of the subject, but it is hoped that it will serve to draw attention to the desirability of controlling the more important diseases, and so increasing crop yields wherever possible. There is available an extensive literature on diseases and pests specially written for farmers, market gardeners and, recently, for allotment holders, while the three Agricultural Colleges and the Department of Agriculture provide specialist advisory services. It is hoped that full use will be made of them.

WAR ON INSECT PESTS.

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Insect pests are the bugbear of the grower whether he be farmer, market gardener, orchardist or allotment holder. Each year they exact a heavy toll which, whilst it cannot be accurately computed, must run into millions of pounds. Losses of this order of magnitude are serious at any time, but they are all the more so during war time, when it behoves the grower to take all practicable measures to reduce the damage done by pests, and so help to increase the food-yield. On the farm, field crops do not generally lend themselves to the practice of remedial measures because of the high cost of their treatment in proportion to the returns made by such crops. Therefore, in combating pests, the farmer must chiefly rely upon the protection which is offered by modifications of cultural operations such as changes in rotation and plan of cropping, adjustments in the times of sowing, stimulation of plant growth by cultivation or use of manures, and practice of farm hygiene. The aim of these various methods is so to alter conditions as to render them unsuitable for the breeding of the pest, to prevent rather than to cure. Thus their effect, so far as the individual pest is concerned, is wholly indirect, and they add little if anything to the cost of crop production.

Direct measures of controlling pests, on the other hand, involving the use of toxic washes, sprays and dusts, repellents, fumigants and soil sterilisants, belong more particularly to the province of the orchardist, market gardener and glasshouse grower, where the value of the crops is such that they can bear a higher cost of protection than general farm crops.

Each cultivated crop has its own insect pests, the control of which is correlated with their individual habits. A knowledge of the latter is thus the only sure foundation on which to base intelligent measures of control. In a short article such as this it is possible to discuss only a few of the more common and important insect pests of plants, and to consider briefly the methods by which they are customarily controlled. To accomplish this with the greatest economy of space, we propose to define some of the methods now in use, and to exemplify the working of each with reference to particular pests.

I. Methods of Indirect Control.—1. *Rotation.*—The value of crop rotation in relation to pests lies in the fact that very rarely do those of one crop remain over to attack a subsequent and different crop. Pests of cereals, for instance, do not, as a rule, attack potatoes or root crops, so that those that persist in the soil after a cereal crop has been harvested must seek a new breeding

locality the following spring, when the cereal has been replaced by another crop. Wireworms with their long-drawn-out larval stage of four or five years and indiscriminate feeding habits are a notable exception to the rule.

One of the most destructive pests of carrots is the Carrot Fly, which produces at least two generations per year. The flies of the first appear in May and lay their eggs in the soil of carrot beds, to which they are attracted by the smell of the host plant. The maggots which hatch from the eggs burrow down to the lower end of the tap root, into which they penetrate and tunnel. To reduce the risk of attack, cropping should be so arranged that carrots are not grown near fields which were planted with this crop the previous year.

The Wheat Bulb Fly is another pest where due regard must be had to a proper rotation. The fly is on the wing from July to September, when it lays its eggs in bare soil, either fallow land or soil imperfectly covered by plants, such as late potatoes. Winter wheat planted on such land is liable to severe attack the following spring, when the maggots hatch from the overwintering eggs. The attack usually begins in February or March, when the maggot burrows into and destroys the growing point of the central shoot. The injured plant responds by sending out lateral tillers, which contribute materially to its recovery, especially if the ground be firmly rolled when the attack is first observed in March. From the foregoing account it is evident that in localities subject to attacks of the Wheat Bulb Fly, non-susceptible crops like oats or barley should follow potatoes or fallow, and winter wheat should be taken only after ley or another cereal.

The ploughing of old grassland is often associated with wireworm damage to subsequent crops. The season of ploughing is significant since Wireworms subsist for a time on the turned-in turf, but, after it has decayed, the pest proceeds to attack the roots of the young crop. Thus a crop sown in spring in a field which has been ploughed earlier in the same year is likely to suffer less damage than one sown in autumn on land broken from grass the previous summer. On wireworm-infested land the farmer has a choice of several resistant crops, such as peas, beans, mustard, rape and flax. At the present time, however, there is greater need for cereal and potato crops. Potatoes are frequently badly damaged by Wireworms in the second year after grass, when the buried turf has decayed. They should, therefore, be taken as a first crop and followed by a cereal in the second year. The tillering capacity of the latter helps the plants to overcome attack, and this can be further encouraged by consolidation of the ground by rolling.

Apart from rotation there is no satisfactory method of dealing with the Root Eelworm of the potato. The pest has assumed con-

siderable importance in the last few years in this country, and has proved very destructive to the potato crops of small allotment holders. The parasite attacks and destroys the rootlets with the result that the shaws wilt and die. When it is mature the eelworm passes to the surface of the rootlets, and the female becomes transformed to a small round white cyst about quarter the size of a pinhead, which later turns brown. The brown cysts are packed with eggs, which may remain alive in the soil for 7 to 8 years. Soil infested with Root Eelworm is said to be "potato-sick." In the absence of a suitable chemical dressing to destroy the cysts in the soil, the grower must perforce omit potatoes from the rotation in potato-sick soil for at least 5 to 7 years, during which interval a large proportion of the eggs will have either hatched or perished.

The potato is also the host of the Stem Eelworm, which is identical with the eelworm attacking oats, clover, onions, peas and beans, flowering bulbs and many other plants. This eelworm has apparently become divided into races, each of which is confined to a particular food-plant or group of related food-plants, and is not readily interchangeable between one kind of host and another. Thus it is possible to plant potatoes, oats and clover in succession with safety, since each is resistant to attack by the eelworm of the other two. The Stem Eelworm does not affect the haulm and foliage of the potato, and only the tubers show symptoms, consisting of discoloured patches at the surface, that are underlain by brown patches in the deeper tissue infested with large numbers of eelworms. With the spread of the infestation in the potato, cracks appear on the surface, which are followed by rot and desiccation. The worms may then enter the soil and attack fresh tubers or they may remain in the dead tissue. Eelworms can remain in a dried-up condition for at least two years, so that, in fields known to be infested, potatoes should be omitted from the rotation for at least two years.

2. *Cultivation.*—Plants are always liable to severe damage by pests during the early stages of their growth, and cultivation, by assisting their rapid and strong development, enables them better to withstand and overcome attack. It is well known that seedling brassicas growing in a good seed-bed with a fine tilth free from clods are more likely to withstand the ravages of the Turnip Flea Beetle. The plants are particularly prone to damage during the seed-leaf stage, but less so once the first rough leaves have developed. The greatest danger to a crop occurs when a period of dry warm weather coincides with germination. The growth of the seedlings is retarded by warmth and drought, which are, however, favourable to the beetle. Under these conditions the seedlings may be destroyed even before they appear above ground.

Farmers recognise that ploughing and harrowing are instrumental in reducing soil pests such as Wireworms, Leather Jackets, Chafer Grubs and Cutworms. Some are undoubtedly destroyed by being crushed in the disturbance of the soil, whilst others succumb to exposure to untoward weather conditions or to attacks by birds, especially during winter and spring. Damage due to soil-insect pests of cereal crops is aggravated by their habit of migrating from one plant to the next in a row. Consolidation of the soil by rolling as soon as damage is observed not only makes migration less easy to accomplish, but promotes a more rapid and stronger growth of the plants. The importance of rolling the ground as an aid to recovery of winter wheat from attacks of the Wheat Bulb Fly has already been noted.

Where grassland infested with the Leather Jacket or "Grub" is to be cropped, the time of ploughing is a matter of some consequence. Like the Click Beetle, the Crane Fly, parent of the "Grub," lays its eggs in leys and pastures in August and September. If the subsequent crop is to escape attack, the ground should be broken in July or early August before the eggs have been laid. Grub infestation of arable land, unlike that of the Wireworm, lasts only for one year and is not repeated until the land is once more put back to seeds.

3. *Manuring.*—The purpose of manuring the soil is to increase its fertility and so get a high yield per acre. In light infestations of pests manures applied at the proper time help the crop to resist or grow away from attack. Thus light dressings of nitrate of soda to cereal crops in the spring enable them to make good the damage committed to stem and leaf by insects, and they assist an onion crop to withstand the onslaught of the Onion Fly. Care should be exercised in the application of nitrogenous fertilisers, since an excess retards growth, and so prolongs the period over which the plant is open to pest attack. A valuable quality of phosphates is that they promote early ripening. Thus they are helpful in diminishing the damage done to barley by the Gout Fly, the maggot of which injures the ensheathed ear so that it fails to become free.

Another pest that is countered by fertilisers is the Stem Eelworm, which causes the condition known as "tulip root" of oats, and is identified by the swollen stem and the twisted and wrinkled leaves of affected plants. Slight attacks are reduced by applications of sulphate of ammonia, nitrate of soda and potassium sulphate, all of which serve to promote vigorous growth.

Control of Potato Root Eelworm by extension of the rotation, as has already been noticed, is not popular with farmers, since the land cannot be used for potato cropping for several years. Attempts have, therefore, recently been made to discover a chemical

that would destroy the eggs and larvæ of the eelworm in the soil. Applications of calcium cyanamide at the rate of 20 to 30 cwts. per acre have given increased yields, but how much this is due to the action of the cyanamide as a fertiliser and how much to its vermicidal action has not been decided. Calcium and ammonium chloracetate at the rate of 3 to 7 cwts. per acre have likewise been stated to reduce the incidence of the eelworm. Farmyard manure applied in the drills at the rate of 20 cwts. per acre at the time of planting the setts has been said to give good crop yields despite the occurrence of large numbers of cysts on the roots. This treatment, however, has not always been attended by uniformly good results.

4. *Farm Hygiene.*—Here are included all operations which have for their aim the elimination of rubbish, crop remains or weeds, which offer refuge or breeding facilities for insect pests. Many injurious beetles are known to hibernate as adults among plant debris negligently left lying around farmyards or fields. Among these are Flea Beetles, Pea and Bean Weevil and the Pigmy Mangold Beetle, which hibernate in hedge trimmings at the bottom of hedges and in stack-bottoms. By using rubbish heaps as traps for assembling hibernating insect pests, the farmer may exploit them to his own advantage, provided they are burnt before the pests become active and escape to their respective crops in the spring.

Crop remains are no less important than plant refuse in encouraging pests. The Mealy Cabbage Aphis, which destroys young cruciferous plants and renders mature ones unmarketable by heavily infesting the leaves, spends the winter in the egg stage or as a wingless female on old Brussels sprouts, broccoli and cabbage, where it begins to breed again in May and spreads to young transplants in the field. It is thus advisable to plough the old plants under not later than 15th May; otherwise, the stalks should be gathered, piled in heaps and burnt or left to dry.

The rôle of weeds in providing an alternative food supply and breeding material for insect pests has long been recognised, and so, in part, they render ineffectual the control which is exercised by crop rotation. The common and widespread weed, charlock, supports almost all the insect pests of cruciferous crops, including the Turnip Flea Beetle, Diamond Back Moth, Cabbage Aphides, Swede Midge, and the Turnip and Cabbage Gall Weevil. The Mangold Fly and the Bean Aphis may breed on thistle and goose-foot, whilst the dock harbours the caterpillars of the Rosy Rustic Moth, which bore into the stems of potatoes, destroying the affected plants. Where cereal crops are concerned, couch grass or twitch is altogether undesirable, since it fosters the Wheat Bulb Fly of winter wheat, the Gout Fly of barley and the Frit Fly of oats by providing breeding facilities for these and other pests. There is, therefore,

very good reason why the farmer should take steps to suppress weeds and clean up neglected, weedy corners and waste places, from which insects migrate to crops.

5. *Time of Sowing.*—Crops that are liable to insect attack at an early stage of their existence in spring may be protected either by advancing or retarding the time of sowing. Early sowing gives the plants a chance to grow beyond the susceptible stage before the pest appears, whilst the object of late sowing is to withhold the crop until the insect has completed the laying of its eggs. Alteration of the dates of sowing, however, may not always be attended by good results, since the rate of growth of early-sown crops is very much a function of weather, and late-sown crops, too, may be checked by unsuitable conditions, such as drought, that may finally affect the yield. In any case the efficacy of the method will depend upon the extent to which it is locally adopted in coping with particular pests.

Two examples of the advantages of early sowing are provided by the Frit Fly and the Gout Fly. The former lays its eggs on the young plants of spring oats, and the maggot bores into and destroys the growing point of the central shoot. Plants that have reached the four-leaf stage have been found to be less liable to damage than are younger ones. Thus it is advisable to sow oats early, so that the crop may have reached the four-leaf stage before the fly appears in the middle of May. In barley the stage that is vulnerable to Gout Fly attack is that of the ensheathed ear, when the plant is about 12 inches high. After the ear has shot it is safe from attack. Sowing of barley should, therefore, be done early enough so that the crop may reach the "shot" stage before the fly begins to lay its eggs on the leaves in June.

Other crops that are likely to benefit from early sowing are carrots and onions subject to attack by the Carrot Fly and Onion Fly respectively. Early varieties of carrots should be sown in February and March, where soil and weather permit, and the sowing of the main crop should be deferred until the middle of July. For the latter, a variety like "Early Horn" should be chosen, which will grow large enough during the remainder of the season for storing for winter use.

II. Direct Control.—Methods of direct control are chiefly employed to cope with infestations of insect and allied pests, which must be dealt with quickly and timeously in order to save affected crops. Their effect is remedial rather than preventive, and they involve the applicaton to cultivated plants of chemical substances in the form of sprays or dusts, which destroy the insect either by being ingested or by contact. Where it is difficult or uneconomical to spray or dust a crop, poisoned baits are sometimes used and have

proved effective in dealing with Cutworms, Leather Jackets and Slugs.

1. *Sprays and Dusts.*—The application of sprays and dusts in the control of caterpillar pests in orchard and market-gardening practice is so well known that it is not necessary to discourse at length upon the subject here. Arsenical compounds find their principal use in controlling the defoliating larvæ of Winter Moths and Sawflies, as well as the grubs and adults of leaf-eating beetles and weevils. There is, however, a natural aversion to the applica- of arsenic on fruit near picking time, and on vegetable crops, with the result that it is replaced by derris or pyrethrum, both of which are harmless to human beings. Weak concentrations of nicotine may also be employed, and, mixed with lime-sulphur and Bordeaux mixture, it forms combined sprays, which are at once insecticidal as well as fungicidal.

In recent years summer spraying of orchard trees has become less significant with the introduction of tar-distillate and petroleum-oil winter washes for the destruction of the overwintering eggs of many important insect pests such as Aphides, Apple Sucker, Winter Moths, Capsid Bugs and Apple Red Spider. The eggs are laid on the bark of twigs, fruit spurs, at the base of buds and on pruned surfaces. Those of Capsid Bugs and Red Spider have proved to be resistant to tar-distillate washes, but are killed by petroleum-oil washes. Tar-distillate washes are applied to the trees up to the end of January or beginning of February, when they are dormant. In applying the washes the grower should be careful to follow the instructions of the manufacturers both as regards concentration and time of application, which varies with different kinds of fruit trees. It should be noted that regular spraying in orchards with lime-sulphur for the control of scab in apples also serves to check Red Spider.

On the whole, insecticidal dusts may not be so efficient as wet sprays in insect control, but the cost of their application is less than that ot sprays. To avoid wastage they should be applied to the plants to be treated on calm days, preferably early morning or late evening. Derris dust is now widely used for the control of the Raspberry Beetle, Gooseberry Sawfly and the Gooseberry Moth, Apple and Strawberry Blossom Weevils, Flea Beetles ("Turnip Fly") and Pea and Bean Weevils. Wasps, too, can be readily destroyed by derris, which is introduced by a blower or bellows into the entrance of the nest. Derris, again, has its uses in the control of lice and fleas of domestic animals and, combined with soap solution, is the only effective insecticide for the destruction of warble maggots in the back of cattle.

Among alkaloidal insecticides nicotine is employed for reducing infestations of Aphides on cruciferous crops grown in market

gardens. The plants should be dusted in June with a 3 per cent. nicotine powder applied at the rate of 40 lbs. per acre, whilst brassicas are dipped in a wash consisting of 3 oz. of 98 per cent. nicotine, 4 lbs. soft soap and 100 gals. water, before they are planted out.

The discovery that calomel is toxic to the eggs and maggots of the Onion Fly and Cabbage Root Fly is a useful and desirable contribution to the problem of controlling these pests. To protect onions and leeks from the former the grower may treat the seed with a 4 per cent calomel dust made adherent by means of starch- or flour-paste and applied at the rate of 1 lb. of dust to 1 lb. of seed. Alternatively, the dust may be applied directly to the rows of seedlings in the field in a thin straddling band two to three inches wide, first when they are 1 inch tall and second, ten days later. Cauliflowers and Brussels sprouts require a double treatment of the dust, the first 3 to 4 days after planting and the second 3 to 4 weeks later. For cauliflowers the dosage is 1 lb. per 100 plants, and for Brussels sprouts it is 1 lb. per 160 plants. The dust is applied uniformly on the soil around each plant by means of a hand dusting machine.

2. *Poison and other Baits.*—Baits rely for their efficacy as insecticides on the greater attraction they have for pests than their customary food Thus "Grub" infestation in oats is controlled by a bait consisting of 25 lbs. of moist bran poisoned with 1 lb. of Paris green, which is sufficient to treat one acre. The mixture is thinly and evenly broadcast over the infested field in the afternoon or evening. Paris green, it should be noted, is a powerful poison, and due care should be taken in its use. Another pest that has proved itself amenable to control by a poison bait is the Slug, which damages potatoes and market-garden crops. Here the bait is composed of metaldehyde, sold as "Meta," and moist bran in the ratio of 1 to 50 by weight. The mixture is either broadcast or distributed in small heaps over the infested ground at the rate of 25 lbs. per acre.

In glasshouses a simple method of dealing with Wireworms is to bait the soil with potatoes or carrots buried two or three inches beneath the surface, each stuck on the end of a small protruding stake. The baits are set two feet apart between the rows of plants, such as tomatoes, which require protection. The baits are periodically lifted and examined, and any adhering Wireworms destroyed. Investigation has shown that germinating seeds of wheat or oats are very attractive to Wireworms. The seed is sown in rows 2 to 4 ft. apart, and the Wireworms assemble in 2 or 3 weeks at the germinated seed, whence they may be collected by hand, or the rows lifted with the Wireworms and burnt. Still another method of dealing with the assembled Wireworms is to drill

calcium cyanamide below the seeds at the rate of 1 lb. per 100 ft. of row. Out-of-doors, wheat intersown with beet is said to protect the latter against Wireworms.

3. *Traps and Trap-Crops.*—Advantage can sometimes be taken of a peculiar habit in order to trap an insect pest. Flea-beetles, for example, readily jump from their food-plants when disturbed by movement, and a device has been constructed to catch them. It is composed of two wheels mounted on an axle 6 to 7 ft. long and fitted with a pair of handles so that it may be pushed along the rows of turnips. Suspended from the axle, and the same width as the axle, is a piece of sacking smeared with tar and reaching the ground. The beetles are disturbed by the motion of the device, jump to escape and so stick to the tarred sacking.

Grease-bands and shelter-bands in orchards are in the nature of traps. The former are used to capture the wingless females of Winter Moths, which emerge from their chrysalids in the ground in autumn and winter, and creep up the trunks and branches of the trees to lay their eggs on the twigs and fruit-spurs. A grease-band 3 inches wide is smeared on an eight-inch strip of grease-proof paper, which is tied around the trunk at 3 to 5 ft. from the ground and maintained there from October to April. A grease made of vegetable oils and non-injurious to the trees can now be obtained and applied direct to the bark. The sticky bands intercept the upward migration of the moths, which are effectively caught and held. Shelter-bands are non-adhesive and are used to trap the mature caterpillars of the Codlin Moth of apple in their descent from the fruit along the branches to the crevices of the rough bark of the trunk, where they spin their cocoons and spend the winter. The band, which is made of sacking or corrugated cardboard, is tied to the trunk in July, one just below the main branches and another near the base of the trunk. The caterpillars spin their cocoons in the bands, and these are removed in autumn and burned.

The purpose of trap-cropping is to induce injurious pests to breed on an early-sown sample of crop, which is lifted and destroyed before the main crop is planted. The method has its possibilities in controlling insects like the Swede Midge and Potato Root Eelworm. Infestation of cruciferous plants by the Swede Midge starts in June, when the first generation of the midge emerges from the soil and lays its eggs on the leaves. A strip of swedes sown around the headlands of a field infested the previous year will attract the midge to lay. When the maggots have hatched after four days, the infested swedes are lifted and destroyed. The infective stage of the Potato Root Eelworm is the minute worm, which hatches from the brown cysts in the soil about 12 days after the tubers are planted. The next generation of cysts does not appear in the roots of the growing plants until

at least 30 days after the young have penetrated." "A trap-crop would thus require to be removed and destroyed 4 or 5 weeks after planting, according as the trap-crop is planted after or before May 1.

4. *Glasshouse Pests.*—Pests of glasshouse crops include Aphides, Thrips, White Fly and Mealy Bugs, all of which are controlled by fumigation with insecticidal vapours. The fumigants that are in common use are hydrocyanic acid gas, nicotine and tetrachlorethane. During fumigation the temperature of the house should be about 65° F. and the relative humidity 80 to 85 per cent. Dosages vary with the fumigant, the insect and the crop, and growers who are not versed in the use of fumigants had best consult a member of the Horticultural Staffs of the Colleges of Agriculture.

Infestations of the Root Knot Eelworm and the Potato Eelworm, both of which are important pests of tomatoes, can only be satisfactorily dealt with by steam sterilisation of the soil. By this process the temperature of the soil is raised to about 200° F. to a depth of 2 ft., and, since a temperature of 140° F. is sufficient to kill soil-inhabiting animals, eelworms are destroyed together with all stages of soil insects, millepedes, symphylids and mites.

5. *Repellents.*—The action of repellent substances on insects is the opposite of that of baits. Except in high concentrations they are not usually toxic to insects, but rather cause them to withdraw before a toxic concentration is reached. Naphthalene is very commonly used as a repellent against the Carrot Fly and the Cabbage Root Fly. For the former two ounces per square yard are applied to carrot beds three times at intervals of 10 days beginning with singling. For the latter ¼ oz. of naphthalene is applied to each plant and the treatment repeated three times at 10-day intervals from about 20th May. Chafer Grubs in lawns and leys are readily controlled by naphthalene, which, because of the more or less sedentary habits of the insect, gets a chance to exert a toxic effect. Toxicity is greatly enhanced when the naphthalene is washed into the soil by rain shortly after the application. Dressings of two or more hundredweights per acre should be made.

Enquiries.—Farmers and others requiring advice concerning insect pests should address their enquiries to the College of Agriculture which serves their particular area.

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AGRICULTURE AND THE WAR MACHINE.

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Through all the ages agriculture and war have been regarded as mutually antagonistic; it has been left to this generation to fuse them and make agriculture simply a part of the war machine. We have only recently begun to do this : the Germans, on the other hand, were already on the way some ten years ago and so have a considerable start over us. We have, however, some advantages which they lack.

In this country the farmer's peace-time aim was to keep his farm going, often no easy task. He produced whatever in his judgment seemed most likely to achieve this end, using whatever materials suited him best, regardless of where they came from. He was under no sort of restriction, and could accept or reject any advice given to him. Large quantities of fertilisers and feeding-stuffs were imported from many different countries, quite regardless of whether or not they could have been produced in this country. Many farmers frankly did little more than "processing": they imported feeding-stuffs from overseas and converted them into meat and milk.

German agriculture, on the other hand, has for some years past been very carefully organised to make the nation as nearly self-sufficient as possible. The German farmer had no need to worry about his own position: prices were fixed by the State at a satisfactory level, and labour could not easily move away from the land; all that had to be done was to obey orders and produce the required foods, but he had to be as far as possible self-sufficient and independent of imported materials. He was shown how to do this.[1] The whole German nation was put on to the dietary that the farmers could produce, and as a result the Germans

[1] In spite of all the organisation before the war German agriculture had been moving in the same direction as British agriculture, though to a much less extent. The area of arable land was shrinking and the grass was increasing; livestock were forming a larger part, and arable crops a smaller part of the total output; and until stronger measures were taken the number of agricultural workers was diminishing.

have much less change to make in their food and their farming than we have.

Our peace-time dietary was much richer and more varied than the German. We were far from being self-sufficient, indeed only 40 per cent., reckoned in money value, of our food was produced here, and 60 per cent. was imported. Worse still, so far as war is concerned, the 40 per cent. home production was not evenly spread over the staple foods. We produced roughly about 10 per cent. of our butter, 20 per cent. of our wheat and flour, 30 per cent. of our cheese, and 50 per cent. of our meat; but nearly all of our oats and potatoes and all of our liquid milk. Our imported foods and drinks came from almost every part of the civilised world. If you went into a small village shop and noted the country of origin of each of the foodstuffs you would have needed a world atlas to place them all.

Our dietary, like our agriculture, presupposed peace and a highly organised and delicately adjusted international trade. It was, in fact, rather extravagant in its demand on the land. About 2 acres were needed on the average to produce the food of one head of population. This, however, included a good deal of land in overseas countries where the yields are lower than ours: at British levels of yield the area of land needed was about 1·6-1·7 acres per head; *i.e.*, to feed 10 people some 17 acres were necessary.[1]

The German peace-time dietary, on the other hand, was much simpler than ours: it included only little that had to be imported, and it made much less demand on the land than ours did. At British levels of yield (which are not very different from the German) about 1 acre per head was needed just before the war, *i.e.*, 17 acres would feed, not 10 persons as here, but 17. Had we adopted the German dietary in peace-time we could have produced not 40 but 70 per cent. of our food, and it would have been fairly easy to push up the yields to make this figure 80 per cent. Theirs was not an interesting dietary: compared with ours there was twice as much potatoes, only half as much sugar, less butter, little lamb or mutton, and only half as much beef, and that not well finished. Two years before the war a well-placed individual, who could certainly get whatever was to be had, told me, as I was crossing Germany, of his "yearning" for the beautiful quality beef he had been able to get in London but not in Germany. I

[1] Two separate estimates can be made: (a) The population of Great Britain in peace-time was about 46 millions: 40 per cent. of the food for these corresponds to the feeding of 18½ millions. We had 32 million acres of cultivated land: this works out to nearly 18 acres per 10 persons. (b) The areas of land which at average yields would give the quantities of the different foods needed per head of population are set out in Table 1. Official estimates are available for the yields of arable crops, but we have to assume values for yields of meat and milk. This gives 16 acres per 10 persons.

told him that it was still produced in these Islands, and there was no good reason why he should not have as much as he wanted— but he shook his head sadly.

The two dietaries are set out in Table I. along with an estimate of the areas of land needed on average British yields for arable crops and, in absence of statistics, assumed yields for meat and milk.[1]

TABLE I.

	Food Consumption Pounds per head per annum (P. Lamartine Yates). Great Britain.	Germany.	Land required for production at British levels of yield: acres. Great Britain.	Germany.
Bread and Flour	197	222	0·15	0·16
Potatoes	210	398	0·05	0·03
Sugar	109	56	0·04	0·02
Beef and Veal	66	34	0·60	0·31
Pork	48	65	0·18	0·25
Mutton and other meat	29	—	0·26	—
(All meat	143	100)	(1·04	0·56)
Milk (gall.)	20	21	0·06	0·06
Butter	22	16·4	0·18	0·14
Margarine	8	15·5	—	—
Cheese	9·5	12·6	0·02	0·03
Eggs (No.)	153	126	—	—
				1·00
Other foods			0·1	·05
			1·60	1·05

Fish, fruit and vegetables are not included in the above table; the figures for Great Britain in 1934 were, in lb. per head:—Fish, about 40-45; Vegetables, 100; Fruit, 115. The German consumption of vegetables and fruit was lower, but, like ours, was expanding.

This great difference in the dietaries of the two nations caused wide differences in the agriculture, but made German farming much simpler than ours. The data have been collected in a valuable book by P. Lamartine Yates.[2] Far more of their land is under the plough than here—68 per cent. as against 41 per cent. in Great Britain: much of it is worked on a three-course rotation, corn—corn

[1] 110 lb. meat (220 lb. live weight) per acre for beef and mutton. 300 gallons milk per acre. Pork—from arable land: 7 lb. barley = 1 lb. pork.

[2] P. Lamartine Yates. *Food Production in Western Europe*. Longmans, 1940.

—roots; or a six-course, corn—corn—roots—corn—corn—grass, and the commonest corn crop is rye, the easiest of all to grow. Much more labour is employed per 100 acres, but it is less efficient than ours. In Great Britain one agricultural worker (including the farmer) feeds about 17 "persons"[1] and has a net output of about £200 per annum. The German agricultural worker feeds 7 "persons" and has a net output of only £70 per annum. There are correspondingly big differences in the numbers of livestock per worker, and the numbers of workers per 100 acres of cultivated land. It cannot be too clearly stated that the British agricultural worker has a higher value of output per annum than any other agricultural worker in Europe. With all the high rate of labour on the farm, yields are but little higher than in this country, although in consequence of the higher proportion of arable land the average value of output per acre is somewhat higher—£8 in place of our £6 at equal price levels (Table II.).

TABLE II.

Agricultural Output 1937 (P. Lamartine Yates)

	Output per worker		Weekly wages per hired worker (shillings)	Acres per worker	Stock units per worker	Output per acre*	
	Gross	Net				Gross	Net
	£	£				£	£
Great Britain	240	200	30-36	33·8	10·3	7	6
Denmark -	180	155	23-26	15·7	8·4	11	10
Netherlands -	150	120	23-30	9·0	4·9	17	14
Belgium -	110	100	18-22	7·4	3·4	15	14
Switzerland -	110	100	27-29	7·1	4·3	17	15
France -	90	90	20-28	11·6	2·8	8	8
Germany -	70	70	18-23	7·9	2·8	8	8

* Rough grazings in Great Britain reckoned at half their acreage, and Alpine grazings in Switzerland at one quarter.

The German system needs no modification for war conditions; it is, in fact, an admirable war-time system. The difficulty of labour is completely overcome by collecting from the occupied countries all the men and women desired; questions of wages, conditions of life and of work do not arise, and, as the labour never had been, and from the nature of the system never need be, very efficient, the lack of training and experience is of no great moment. How long can the system last? That remains to be seen, but we must expect that the iron heel on the farm, and the taking of food from occupied countries, will keep Germany sufficiently fed for a long time to come.

The small proportion of grass and of roots in Germany is explained by the smaller importance of livestock in German than in British agriculture. Nevertheless, the output of milk and pork

[1] O. J. Beilby. *Empire Jl. Expt. Agric.* 1941, Vol. 9, pp. 137-144.

had to be maintained, and the Germans showed great ingenuity in providing home-grown feeding-stuffs. Twelve years ago, before the present programme was developed, they used to import some 30 per cent. of their total concentrates; but this was rapidly dropped to less than 10 per cent.; we, on the other hand, imported about 66 per cent. This drop in Germany was brought about in several ways. Ensilage was developed, portable outfits for steaming potatoes for livestock were put in circulation, fodder crops were extended and the grassland improved. A system of pig-feeding was worked out which reduced to a minimum the grain required, and made full use of home-grown fodder. The Germans are less likely to have to reduce total numbers of livestock than we are.

The difference in position of livestock in German and in British agriculture affects the manuring of the crops; in Great Britain most of our nitrogen and potash (though not phosphate) is supplied from farmyard manure, but in Germany more has to come from artificial fertilisers. That means a higher consumption of fertilisers than here, which, however, presents no difficulty. Nitrogenous fertilisers are made from the air, and so long as the factories remain at work the output can be maintained. Potash is almost entirely in German hands; they always had the chief deposits, and in addition now control the Alsatian and the Polish mines. Phosphate supplies caused them difficulty in the last war, but perhaps less in this; the chief source is French North Africa, but in the last 20 years other sources have been opened up. The conversion of insoluble mineral into soluble phosphate could not easily be done in the last war, but methods have in the meantime been developed.

The more closely one compares German and British agriculture the more it appears that German agriculture has for some years been an integral part of the war machine and, therefore, need now suffer little change, while ours has not, and we have to make considerable changes now while the war is on us, just as we did in the last war. In some respects our position is better now than it was then. Farmers and farm workers are much better organised than they were so that changes can be made far more quickly. The War Agricultural Committees are not new people, and their officers have usually already held posts as organisers, and know their counties and their farmers well. The research and advisory services are in full working order; problems as they arise can be dealt with, even if a perfect solution cannot always be found. It was, of course, unfortunate that the problems raised in the last war were not satisfactorily solved in the years of peace; we are once again back at some of them:—control of wireworms, manurial value of town refuse, sewage sludge and other wastes, utilisation of mineral phosphate, of straw, etc., all of which had

been set aside in 1919 for problems that then became more urgent.

We cannot hope to maintain our peace-time dietary during the war, and the changes must be considerably more drastic than any needed in Germany. Our consumption of meat, sugar, eggs and cheese must be cut down, and we must provide for an increased consumption of bread, potatoes and vegetables. Fortunately our people are taking the change in dietary very much better than might have been expected, in view of British conservatism in the matter of food, and fortunately also the new dietary seems to be as wholesome and as sustaining as the old one, thanks to the care taken in rationing, advice about cooking and the establishment of canteens.

The change in dietary involves corresponding changes in our farming :—

(1) A large increase in production of cereals, potatoes and sugar beet, all wanted for human food;

(2) Full maintenance and, if possible, increase of milk, in spite of the fact that some of the imported foodstuffs are cut off;

(3) As high an output as possible of meat and eggs as long as this does not hamper (1) and (2);

(4) An increased output of vegetables and fruit.

The Increase in Output.

I. Our Energy Supplies.

Cereals.—Wheat and, to a less extent, oats furnish the major part of our energy requirements. In peace-time we produced only about one-quarter of our total consumption of wheat, and a fair amount went to poultry, so that less than a quarter of the human consumption was provided from home sources. On English farms the output of wheat will increase considerably during the war, and this is a great comfort in view of the supreme importance of having unlimited bread supplies. Fortunately, also, wheat is one of the easiest of all foods to transport, and ample supplies are in Canada, the shortest of the long sea voyages.

Oats are in a rather special position. Thanks to an effective publicity campaign the consumption of oatmeal seems to be increasing in England, indeed in some places the housewives' enthusiasm ran ahead of the shopkeepers' supplies. This development is wholly beneficial, and those farmers who can grow good quality oats should increase their output in every way possible.

In the old days rye was often used for human food, and then it was given up in this country, although much used in Germany. More recently, however, increasing use is being made of rye for special foods. The grain is grown on contract, and I am informed that no less than 6,500 acres are wanted this season.

Potatoes.—These constitute the second most important source of our energy requirements and, indeed, they give a larger energy return per acre than any other crop. An acre of potatoes provides approximately twice as many calories as an acre of wheat or oats.[1] Potatoes are in the special position that in peace-time we satisfied almost the whole of our requirements, importing as a rule only a certain number of earlies. We have therefore no leeway to make up here. But our peace-time annual consumption was only about 200 lb. per head as against 400 lb. in Germany, and the curtailing of meat, fish and eggs should lead to a larger consumption. Hence the drive for a larger potato output in gardens and allotments, and on farms. Certain conditions must, however, be fulfilled. The seed must be both vigorous and free from disease. There is a real danger in extending the cultivation of potatoes that its diseases also are spread, notably the virus diseases, unless special care is taken to ensure healthy seed, and yet the cultivation of potatoes must be much more widely spread. In peace-time it is one of the most local of all our crops, being confined largely to the eastern part of England and Scotland, and to certain restricted areas in the west. In war-time transport cannot be spared, and there should be a much larger measure of local self-sufficiency. As it is quite impossible to foretell the yield, this increased acreage may result in crops in excess of what the markets would normally take. In peace-time this risk was a powerful deterrent against extending too much the potato acreage; in war-time not only must risk be taken, but one must hope that the bumper crop will come. The financial risk is borne by the Government, but the utilisation of excess potatoes is one of the most urgent of war-time problems. More human consumption can be encouraged by the development of special methods of treatment, such as chips, crisps, etc.; above all by suitable propaganda in the towns, establishment of potato bars, etc. Potatoes can also be used for the manufacture of farina or other foodstuff, or as food for livestock, especially if travelling cookers could be sent round. The problem should be taken in hand before the crop is ready.

[1] Wheat gives flour furnishing about 2·6 million calories per acre at 17·7 cwt. yield, less 1·4 cwt. per seed, and 85 per cent. extraction for flour; while potatoes at 6·5 tons per acre yield, less 0·8 tons for seed and allowing for waste in peeling, give 5 million calories.

II. Our Protein Supplies.

Protein for ourselves.—In the last war it was commonly stated that a reasonable dietary supplying enough energy would almost always supply enough nitrogen also. This may be so, but, unfortunately, the nitrogen in grains, *e.g.* wheat, oats, beans, etc., has not the same biological value as the nitrogen in animal products, meat, fish, milk and eggs. It is significant that in peacetime the British and American peoples eat more animal protein than most other races, and it seems reasonable to attribute a good deal of our driving force to that circumstance.

The proteins of green leaves seem to be in a different category, and some of them appear to have distinctly higher biological value than those of seeds. Green leaves, however, are not a good source of protein for human beings because of their large content of cellulose and fibre, which we cannot digest directly, although micro-organisms in the intestine can bring about decomposition. If it should become necessary, it would almost certainly be possible to separate the protein from these less useful constituents and make it available as human food. For the present most of the first-class protein comes from animal sources, and it must be admitted that there is ground for uneasiness on this account.

We started the war with a large population of livestock, in some ways larger than ever before, but the restriction on imported feeding-stuffs has compelled reduction; we have also reduced our import of finished animal foods—meat, eggs, cheese, etc. More labour and more skill are required in the production of animal than of vegetable protein. For many reasons, therefore, our supplies of high-class animal protein will tend to go down. Yet it is difficult to see how hard manual work can be done without it. Special arrangements have been made to supply additional cheese to agricultural workers and miners, and canteens make possible supplies for other workers. It is, however, up to the farmer to increase the output in every way possible: the power of endurance of our workers may still turn on this factor.

Protein for livestock.—While animals can transform second-class plant proteins into first-class ones they cannot make protein out of simple substances: only plants can do this; they alone have the remarkable power of building up proteins out of simple compounds like ammonia or nitrate. Kale is outstanding in this way, and is well ahead of most other crops. The numbers of pounds of protein equivalent and of starch equivalent made from 1 cwt. of sulphate of ammonia are on an average:—

	Kale	Oats Grain	Oats Straw	Swedes	Potatoes	Meadow hay
Protein equivalent	44	21	6	16	13	26
Starch equivalent	302	168	114	157	403	174

It is certain that we do not use anything like enough sulphate of ammonia. In peace-time "Safety First" may be a justifiable rule; but in war-time there can be no fear of overproduction, and probably most of our crops would bear another cwt. per acre of sulphate of ammonia. In regard to other fertilisers the restricted supplies of potash and phosphate have made soil analysis more than usually important so as to ensure that these shall be used to the best advantage.

On most farms, however, the chief source of protein, or more strictly protein equivalent, for livestock is grass. Dr Norman Wright estimates that of the total of 3·7 million tons of protein equivalent consumed annually by the livestock of the United Kingdom in the years before the war, no less than 2·1 million tons came from temporary and permanent grass, 1 million was imported and 0·6 million came from home-grown cereals, roots, straw, various by-products, etc. Almost as high a proportion of the starch equivalent was supplied by temporary and permanent grass: 12·5 million tons out of 21·2 million tons. Our present problem is to see how much protein and starch equivalent we can continue to produce, because this affects the supply of first-class protein available for human beings. This is the justification for the emphasis now being laid on grassland improvement; we are compelled to plough some of our present grass in order to increase our acreage of cereals and potatoes, and so the remaining grass must be improved to make the smaller area as far as possible do the work of the larger one. Fortunately the methods are well known, and they have been so well described in this Journal that there is no need to repeat them. We can, too, take a leaf out of the German farmer's book and make more use of silage as a means of saving some of the excess of summer grass and holding it for the winter.

Increasing our area of cultivated land.—Although we cannot, like the Germans, requisition our neighbours' lands and crops, we possess a considerable reserve of land that can be converted to better use than was economically practicable in peace-time, and its improvement has become an urgent war-time necessity. Much of this land has been cultivated in olden days, especially in the great wars of Napoleon's time and in 1914-18, and methods of utilisation are now known. Some Agricultural Committees are already doing a great deal in this direction: Norfolk, for example, is starting on a 10,000 acre tract near Feltwell and some 4,000 acres in the Brekland region; when the full story of what is being done in other counties can be told the total will probably be impressive. It is now much easier than ever before to tackle this job; suitable tractors and other implements have been designed,

and numerous experiments have already been made to test various possibilities. The situation in regard to animal food supply is so serious as to justify every possible effort to improve it, and any farmer who, without prejudice to his output of grain and potatoes, can squeeze out from his farm a few more animals for the butcher, or more gallons of milk, or more eggs, and put them on the market, is doing a public service.

The curtailment of the grassland and of supplies of imported feeding-stuffs must of course reduce the numbers of livestock in the country, but the reduction need not be too drastic. On our own farm of 375 acres our head of livestock in the last year of peace was 112 cattle and a breeding flock of 300 Border Leicester ewes: in the summer our livestock population would be about 136 cattle and calves, and 830 sheep and lambs, this being well above the average.[1] We had 216 acres permanent grass and 133 acres arable, and we purchased some 85 tons of feeding-stuffs. We have now ploughed up 54½ acres of our permanent grass, thus reducing its area by 25 per cent., and our purchases of feeding-stuffs will this year be cut down 50 per cent. But the head of stock is not being proportionately reduced: the sheep are down only by 25 per cent. to 606 (225 breeding ewes and 379 lambs) and the cattle by 33 per cent. to 84. Even these reductions are greater than they need be on an ordinary farm where the density of stocking would be much lower. Our pig population is actually going up, but this is for a special reason: when we bought the estate in 1934 it comprised 75 acres of woodland, of which about 55 were felled by the vendor; we did not wish to replant so much, and so we are changing about 40 acres into grassland. The tree roots effectively prevent ploughing up, so we turned in some Tamworths, and they are such hardy, industrious diggers that they clear the ground, leaving us with only a few shrub-like growths to tear out with a tractor, after which seeding by hand becomes possible.

Scotland has a particularly interesting set of problems in connection with the 10 million acres of hill grazings and deer forests lying below the 1500 ft. level, some of which at any rate offer hope of improvement by the introduction of mixed cattle and sheep grazing, by cutting bracken, by drainage, liming, manuring, etc.

However, it is no use improving the remaining grassland unless this is accompanied by a drastic culling of livestock that are not pulling their weight on the farm. Milk recording has helped a great deal here: in England and Wales the Societies show a steady rise in yield from 473 gallons per head in 1919-20 to 546 gallons

[1] The average for England and Wales for 1939 was, per 100 acres farmed land, 27 cattle: 72 sheep; our figures were 36 cattle: 263 sheep.

per head in 1935-36.[1] Many instances could be given of benefits derived from culling, and the present inducements to sell should encourage this.

The ploughing up of grassland in England will, it is hoped, encourage the folding of sheep on arable land. This is one of the surest ways of maintaining fertility of the light soils, especially now that the supply of farmyard manure is likely to be restricted owing to the curtailment of purchased feeding-stuffs. If the war goes on long enough we may yet see some of the old folding breeds become more popular. But, in the meantime, the Border Leicester-Cheviot remains high in favour, and the more culling we do in the south the more we shall have to go north to replenish our flocks. So we naturally hope that good breeding stocks will be well looked after.

III. The Protective Foods.

Vitamins and Minerals.—These will undoubtedly play an increasingly important part in the war; they include vegetables and fruit in addition to milk and potatoes already mentioned. Our consumption of fruit and vegetables had been steadily increasing; it is difficult to estimate the quantities eaten because of the large amounts grown in private gardens and allotments. The last peace-time figures indicated a consumption of the order of 115 lb. of fruit and 100 lb. of vegetables per head per annum. Of the fruit a large part was imported; the most popular were apples, oranges and bananas. These imports are now very heavily curtailed, and we are down to the supplies produced at home. This makes a severe cut into the important protective foods and makes it imperative that those who can grow fruit should intensify their production.

Black-currants come first in the list of fruits as suppliers of vitamins and minerals, but strawberries and raspberries stand high also. On the other hand, some of the luxury fruits, grapes, pears, melons, etc., are much lower down, and so we can console ourselves if we have to go without them.

Vegetables were always mainly produced at home, and their cultivation was far more widely spread than that of fruit. They serve three purposes: as nutrients, as sources of vitamins and minerals, and as flavouring materials. Their nutrient value is not high, though carrots, broad beans, and peas are fairly good; and the protein of the green leaf vegetables, spinach, Brussels sprouts, etc., though small in amount, is good biologically. The

[1] It is not necessary to remind readers of the difficulty of defining "annual milk yield" and of the resulting uncertainty of many of the statistics. The Milk Recording Societies have adopted a precise definition and stuck to it, so that their figures are really comparable.

chief value of vegetables lies in their protective and flavouring properties. Fortunately, vegetables are as good as fruit for supplying vitamins and minerals, and so long as we are well provided with them our dietary need not suffer. But economy of transport is even more important than for potatoes, as vegetables rapidly lose some of their vitamins if they are kept long. Local self-sufficiency must be the aim, and farmers having access to large town and city markets should enquire into the possibilities of vegetable production. Great efforts are being made to increase the output from allotments and gardens, but these will not nearly suffice, and there will be a big demand for more. Sprouting broccoli and Brussels sprouts are among the best vegetables for supplying vitamins and minerals, while some of the luxury vegetables, asparagus, etc., come near the bottom of the list. Onions are low in vitamin content but have considerable value for flavouring; many people never appreciated them till they became scarce in 1941, and one can expect a sustained demand in 1942. With the curtailment of meat, and the greater predominance of bread and potatoes, the need for more vegetables will be emphasised, and, incidentally, those who have charge of the feeding of land girls and of other workers new to the land should take special care that their dietary includes abundance of fresh vegetables so as to keep them in full health and efficiency.

An Eye on the Future.

It is one of the special characteristics of good farming in Great Britain that it is never done for the day alone; an eye is always kept on the future. It is an old saying that a man should live as though he were going to die to-morrow, but farm as though he were going to live for ever. Many people are a good deal worried about the effects of the present drive for intensive production by using more artificial fertilisers, especially sulphate of ammonia. There would be no fear if abundance of farmyard manure were available, but, unfortunately, this will not be the case, and restrictions on feeding-stuffs will cut supplies down. This is particularly sad because more straw than usual will be available, and the demand and prices for the finished product, whether meat or milk, are sufficiently good to justify every effort at improved production.

The chief dangers of the present position are that the soil may become acid, and that it may lose organic matter or "humus." In spite of the activities of those responsible for the Land Fertility Scheme there remains a great area of land in need of lime. Potatoes, oats, alsike clover and grass suffer least from this defect, but it is a defect, and the official adviser should be consulted as to whether or not lime is needed; the advice costs nothing and it

may save a great deal. The full value of fertilisers cannot be obtained on acid soils.

The farmyard manure should go on the potato or the root crops, but there is not likely to be enough to prevent some of the arable land losing organic matter; this, however, rights itself when the land is put back into a grass-clover mixture, as it should be after some three or four years of arable cropping, and organic matter again accumulates.

The really important thing is that strong efforts should always be made to improve the farm all through the war years. There is a lot of public support now for agriculture. Take full advantage of it. Use every bit of help you can get from whatever quarter for bringing more of the marginal land into cultivation, for getting rid of poor pasture by ploughing it up, and after cropping lay down a better mixture; drain and lime land that needs it, and get the hedges in order.

It is inevitable that there should be more planning in the post-war agriculture than in the past. When peace comes the problems of reconstruction will be as grave as those now confronting us, and will be rendered more difficult by the sharp divisions of opinion which in war-time are in abeyance, but are likely to arise again. Agriculture must obviously put its own house in order, and in doing this it would be very helpful if the numerous surveys made before and during the war could be systematically worked up into County Reports, as was done by the first Board of Agriculture at the end of the 18th and the beginning of the 19th centuries. This would enable the agricultural position to be set out in proper perspective. But agriculture will also have social services to perform; it will be called upon for help in reconditioning suffering people and reconstructing our national life. Some experience was gained after the last war, and this should prove useful when the time comes. Finally, agriculture will always have to play its part in national defence, for we cannot assume that this is our last great struggle; science and engineering will continue to furnish new resources which in the hands of adventurers may be used for conquest and plunder, and national security will always have to be a paramount consideration for peace-loving people. Our agriculture must be developed with the double purpose of serving peace-time needs and of assuring a war-time dietary when next the need arises. We need not, like the Germans, live permanently on a war-time dietary, but we must be able to produce it at very short notice.

For these various reasons our agriculture cannot be left to drift. We are not likely to attempt restrictive measures like some of those adopted by the Germans. For us there is a much better way. We know how much food the nation needs, and when

peace comes and international trade starts up again we can decide what is the minimum below which home production should not fall, and allocate our remaining requirements by trade agreements with the various parts of the Empire, the United States, and other countries. The home production could be allocated on a county basis by the War Agricultural Committees, who could organise a Farmers' Reserve, similar to the Army and Navy Reserves, of men who undertake to deliver specified quantities of the various commodities to the buying organisation. The machinery exists in the Marketing Boards, and the methods would be the placing of contracts, as is done for milk and sugar beet, or the fixing of prices, as is now done for wheat, potatoes, livestock and other products. We are getting used to these methods now and learning how to work them smoothly. We should regard them as part of the permanent machinery of the future and improve them accordingly. We cannot hope, even if we wished, to get back to the old days of unrestricted competition between home and overseas producers; our great problem will be to combine the necessary degree of planning with that freedom of action that has hitherto been characteristic of British agriculture, and to which so much of its high technical efficiency is due.

SCOTTISH AGRICULTURE IN WAR-TIME.[1]

In many ways the year 1940 was exceptional. It was a year of weather extremes—of a great frost in January and February, of a prolonged heat wave in May and June, of an unusually wet July, of one of the best harvests and one of the wettest Novembers ever known. Notwithstanding an unpromising beginning and a backward spring, yet by June all arrears both of work and of plant growth had been overtaken, while crops of all kinds gave distinct promise of satisfactory yields. The prolonged heat wave then experienced was in certain respects not unwelcome. The straw of the already promising grain crops was prevented from becoming too rank and luxuriant, and there was thus little chance of much of these crops becoming lodged, while there was every likelihood of the harvest being early and comparatively easily handled. July, from the haymaking point of view, was a disappointing month, but its heavy rains freshened the pastures and provided sufficient moisture for the developing root crops. The grain harvest commenced in the earlier districts by mid-August,

[1] This article is in continuation of one which appeared under the same title in the January, 1941, issue of the *Journal* (Vol. XXIII., No. 2) and covered the period of the first nine months of War.

and from then up to the middle of September the weather was almost ideal. There was little or no dew, there was abundance of drying winds and there was a complete absence of broken weather. Under these conditions, and aided by willing helpers in the shape of roadmen, students, schoolboys, soldiers and the Women's Land Army and its Auxiliary Force, farmers reaped and stacked their grain crops almost in record time. In the latter part of September and in October the weather became rather less settled. The rains which fell then were all required by the turnip crop, but did not interfere unduly with the lifting of an excellent potato crop. Not till November, when the weather broke down altogether, was outdoor work seriously interfered with, and by that time practically all the potato crop had been secured.

Crop Results in 1940.— The general results of the year's working were most satisfactory. The combined effects of a generally increased acreage and higher yields per acre were, according to the estimates furnished by the agricultural returns, most encouraging. The total grain yield exceeded the previous year's figures by twenty-five per cent., that of potatoes by seventeen per cent., while the turnip crop, even on a decreased acreage, gave an increase of thirteen per cent. on the total yield. These results were very helpful in preparing the way for the launching of the campaign for the following season.

Plans for 1941.—Well before the last of the 1940 spring crops had been sown plans for the coming season's food production campaign were being considered and formulated. The experiences gained in the first survey had suggested the advisability of announcing, at as early a date in the summer of 1940 as possible, the policy to be followed and the objectives to be aimed at. This, it was hoped, would bring home to farmers, long before the commencement of the ploughing season, what was expected of them in the way of increased tillage, and enable them to make timeous arrangements for stock adjustments. Thus, if breeding sheep had to be disposed of to permit of extra grassland being ploughed, they could be sold at the autumn sales or fattened off in the closing months of the year. Other adjustments, as regards use of labour, implements, fencing material, etc., could be arranged. Estimates could also be made of the acreages that would have to be ploughed or cultivated by contractors or by the Department's Service for Hire of Tractors. It was also hoped that, by undertaking the survey work during the long days of summer, visiting Committee members would not be pressed for time, and could consequently carry out the inspection work thoroughly. Opportunities would be afforded for studying the crops during the growing season, errors in cultivation, manuring and general management could

then be detected, the extent of damage done by diseases and pests ascertained and remedial measures suggested.

Announcement of Policy.—On June 2nd the Government's general agricultural policy was announced in a broadcast. It was then stated that a vigorous drive towards further increased cultivation was to be made. The labour position was to be safeguarded by such means as the lowering of the reservation age and the placing of restrictions on the movement of agricultural workers to other industries; it was also to be improved by combing the ranks of the unemployed for men of agricultural experience, and by raising the minimum rate of wages to levels comparable with those paid in other industries. To enable this to be done farmers were promised higher prices. "It had been agreed," it was announced, "that much the best and quickest way to get the increased food the nation required was to ensure that the farmer got a decent price and, even more important, knew at once what he was going to get." Farmers were warned that shortage of shipping would mean less feeding-stuffs. The maintenance of the milk supply was so important, however, that dairy cows should be the last to suffer on this account. Certain sacrifices were necessary; a high finish could not be expected when commercial cattle and sheep were being fattened, while poultry and pig keepers, who depended mainly on purchased feeding-stuffs, might have to reduce their numbers to a third by the autumn months.

The effect of this broadcast was reassuring. Uncertainties regarding prices; the bogey of an unsaleable surplus, say of potatoes; and fears that crops which had been laid down might not be harvested for lack of labour were removed. The blunt truth regarding the feeding-stuff position brought home to farmers the necessity of becoming more self-sufficient, and of adjusting their numbers of stock according to the amount of food likely to be available. Farmers were made to feel that both they and their workers were playing a part of vital importance in their country's defence, that sacrifices in certain cases would have to be made, but that, so far as was practicable, everyone in the industry would get a fair deal.

Tillage Area Objective.—This policy implied an even greater increase in the agricultural output of Scotland in 1941 than was attained the previous year. The peak year of the last war, in respect of the acreage of tillage crops, was 1918. Between then and 1939 some 600,000 acres of tillage had been lost to agriculture, a considerable amount, for reasons explained in the previous article[1], being irretrievably lost. If the 1941 tillage figures—allowance being made for this irretrievable loss—were to be at all

[1] *Scottish Journal of Agriculture,* Vol. XXIII., No. 2, January 1941.

commensurate with those of 1918, every effort would have to be made to obtain at the very least an additional tillage acreage of 260,000.

Stock Adjustments.—In many counties a very large part of the acreage lost to tillage since 1918 was being utilised for the grazing of breeding flocks of sheep. In one area the numbers of such sheep had actually been trebled. Obviously if the clearing off, or even a substantial reduction in numbers, of such sheep were a practical proposition in the coming autumn, a large acreage of grassland would become available for ploughing. It was felt, however, that clear guidance should be given as to the order in which the adjustments of the larger stock of the farm should be made to accord with the general food policy of the country. As it happened low ground ewes of a commercial type were, under the circumstances of war, considered to be the least indispensable of all the larger livestock.

Such guidance was given to the Agricultural Executive Committees in the Revised Memorandum on Increased Cultivation of June, 1940, supplemented on the 3rd August by a circular letter giving additional notes on farm management. In these it was suggested that stock reductions should take place in the following order:—Firstly, low ground flocks of commercial breeding ewes; secondly, commercial cattle; thirdly, pedigreed cattle and sheep; leaving dairy cattle to the last.

Practical Difficulties.—It was realised that any extensive diminution in the acreage of grassland, coupled with a consequential reduction in the number of low ground breeding ewes as suggested above, might have serious repercussions on the price of store sheep at the autumn sales. The prices for store sheep at these sales had, at all times, been subject to considerable fluctuations due to circumstances not altogether connected with the prevailing price of mutton. The probable effect of farmers undertaking an increased tillage programme would be to limit the amount of grass available for sheep on the one hand, and, on the other, to throw on to the market an unusual number of breeding ewes from low ground farms. Unless some means of dealing with the situation could be found this would mean that the demand for breeding sheep, including cast ewes off the hill, would be seriously prejudiced. It was true that restocking of deer forests, etc., might tend to ease the situation somewhat, but, obviously, the best method would be to fix fat sheep and lamb prices at such levels that the fat market would attract the greatest number of ewes and lambs at as early a date as possible in the autumn and early winter. The price for light-weight ewe mutton, which in the previous autumn was 6d., was advanced to a general autumn and winter

average of about 11d. per lb., while the establishment of a special grade enabled many light-weight lambs, either directly off the hills or after a comparatively short period of good keep, to be slaughtered and marketed at satisfactory prices. It was rather unfortunate, however, that full advantage was not taken by farmers of the measures which had been expressly adopted to ease the situation at the store sales. The prevailing prices for cast ewes and the smaller classes of lambs at the autumn sales were undoubtedly lower than they need have been, and the buyers often reaped handsome profits.

Guidance as to Increased Cultivation in 1941.—In the Memorandum already referred to opportunity was taken to point out to Committees the general methods that might be adopted in assessing the contributions which individual farmers would be expected to make. These were as follows:—

"(a) Where rotation pastures have been down for two to three years farmers should be asked to break up half of what would normally be the oldest grass. This would mean that, in an easy six-course rotation, seven-twelfths, or approximately 58 per cent. instead of 50 per cent., of the arable land would be under tillage.

"(b) Where on any farm rotation pasture is kept for more than three years, the farmer should be required to plough a break additional to the normal break.

"(c) Where a farm has been laid down to pasture since 1918, the aim should be to convert at least 30 per cent. to tillage.

"(d) In selecting land for cropping, Committees should endeavour to secure land which will give the largest crop responses.

"(e) Consideration should be given to the special needs of dairy farms, and in such districts, as elsewhere, steps should continue to be taken to encourage the renovation of inferior pasture. It is well established that by proper treatment of the land the full normal stock can be maintained even when some of it is ploughed up.

"(f) Emphasis should be laid on the necessity of maintaining existing arable land in good heart through proper cultivation, the adequate use of fertilisers, so far as available, and maintenance of drains when necessary."

Based on these considerations a quota for increased tillage for the harvest of 1941 was intimated to each Committee.

General Farm Management.—It was also pointed out that every effort should be made to increase yields by timeous cultivation, adequate manuring, destruction of pests, prevention of all kinds of waste either during harvesting or storage. With a view to making good a certain amount of the loss of summer grazing,

Committees were asked to make every effort to have the pasture on deer forests, rough grazings, etc., fully utilised. It was realised that, despite the efforts of Committees in the spring of 1940, the fullest advantage had not been taken of such grazings, hence the special reference to this matter.

Importance of Special Crops.—In order to maintain the level of production of home-grown seed of such grasses as Perennial Rye Grass and Timothy, it was suggested that Committees might consider it advisable to refrain from asking farmers to plough up land under such crops, provided it was adequately productive. Land under such crops was not, however, to be classified as land devoted to tillage crops, but grassland which was being ploughed, manured and reseeded direct without a nurse crop could be allowed to count towards any particular area's quota for increased tillage. Committees were also asked to consider the flax crop as being as important as a cereal or potato crop.

Meeting Shortage of Feeding-stuffs.—In the broadcast of June 2nd attention had been drawn to the possibility of a serious shortage of feeding-stuffs. Obviously, such a shortage would have a serious effect on the nation's supply of winter milk unless special steps were taken by dairy farmers to meet the situation. In view of the vital importance of maintaining the milk output throughout the year, dairy farmers were urged to ensure that the whole of their land, and particularly their grassland, should produce as much as possible. Thus, by manuring their grassland, the same head of stock could be grazed on a reduced acreage of grass, thereby releasing land for producing crops which could take the place of imported feeding-stuffs. It was pointed out that young leafy grass, properly ensiled, was in itself a complete and adequate food for a dairy cow. By such means, by ploughing up, manuring and reseeding worn-out pastures, by getting rid of the less profitable cows, by grazing the younger dairy stock on rough grazings, and by reducing the number of animals on the farm not giving milk, it was hoped that the output of milk would be maintained at a high level throughout the whole season. The experience gained in the previous war had indicated that the production of milk was limited not so much by shortage of grass during the summer as by a shortage of feeding-stuffs during the winter.

Survey of Farms.—In order to focus attention on farms which might be capable of producing more, Committees were reminded of certain suggestions made in the first Memorandum on Increased Cultivation issued in September, 1939. In this memorandum it was pointed out that farms might be classified in three groups according to their quality and standard of management.

Class A.—Well managed; fully cropped.

Class B.—Well managed; with possibilities of increased cropping.

Class C.—Not well managed; scope for increased production by better efficiency or change of practice (*e.g.* methods of cropping, kinds of stock kept, balance between stock and cropping).

So engrossed were Committees during their first season on getting their quota increases that, although the classification outlined above had been largely adopted, there had been neither time nor opportunity to consider fully the ways and means of bringing the "B" and "C" farms more into line with the "A" farms. Committees were, therefore, asked to record the particular deficiencies detected and to suggest appropriate remedies. Ordinarily this action would be followed up by giving a direction to the occupier, but, where such a direction would place an obligation of so onerous a character on him that he would be unable to carry it out, or where it was felt that no adequate improvement under the existing management could be looked for, other steps might require to be taken. These might mean the termination of existing tenancies or the taking possession of the land by the appropriate Committee for the purpose of managing it. In general, it was hoped that by making the fullest use of their wide powers in the matter of directions the need for having recourse to extreme measures would arise only in very exceptional cases. Directions could be issued requiring occupiers not merely to plough but also to crop, manure and drain land according to specifications, to effect such repairs as were incidental to food production, to erect or repair fences, to burn heather, to cut down trees and hedges, etc.

In August the Secretary of State for Scotland delegated power to Committees, in terms of the Defence Regulations, to do work on land where a direction given to the owner or occupier had not been complied with. The Committees were asked in the meantime to limit their exercise of this power to certain cases, viz., those where their requirements as to normal farming operations or the destruction of pests had not been complied with. Further, they were asked to consult the Department in other cases where they desired to take action. Non-compliance with a formal direction of a Committee could, of course, previous to this, be followed by a prosecution and penalties, but this procedure did not of itself ensure that the work should not only be done, but done at the proper time. Section 6 of the Agriculture (Miscellaneous War Provisions) (No. 2) Act, 1940, which was passed in August, gave

statutory power to recover expenditure incurred by Committees in the circumstances described.

Progress of Survey.—With an increased sense of their responsibilities, and fortified by the assurances given regarding prices and labour, Committees entered upon their second-year campaign with zest and enthusiasm. Much of the survey work was completed before the commencement of the grain harvest, but in certain areas where haymaking was so delayed by bad weather in July and early August that it overlapped the grain harvest, the survey could not be made until the autumn. By the end of October most Committees were able, however, to complete their preliminary estimates.

Results of Survey.—The general results were most encouraging. In those areas of the North-East where the customary six-course rotation was practised the additional acreage required was readily undertaken. The Eastern County areas, from the Borders in the South to the Moray Firth coast in the North, returned their quotas with only one or two exceptions. The South-Western counties did surprisingly well, considering their particular difficulties in adjusting their numbers of dairy stock to meet the quota requirements. But in most of the Northern counties the results obtained were distinctly disappointing. In these areas much of what had formerly been arable land was out of condition for ploughing, being either unequipped with buildings or defective in drainage, fencing and general fertility. Labour difficulties in these areas were particularly acute, and the limitations imposed by war on the normal coastal transport facilities were an additional hindrance. But, after making allowances for these disabilities, there was considerable ground for thinking that many farmers in those areas did not fully realise the supreme importance, from the national point of view, of growing crops for human consumption, and of making their farms self-sufficient in the matter of feeding-stuffs.

Issue of Directions.—In the previous year Committees had generally used their powers to serve directions only in cases where the grassland to be ploughed could qualify for the £2 per acre subsidy, or where doubts were entertained about an occupier's intention to comply with the expressed wishes of the Committee. One evident weakness of this policy was apparent on examination of the agricultural returns furnished on June 4th, 1940. The actual returns of increased tillage were considerably short of the estimates furnished by the various Committees. It was evident that many farmers had failed to implement their promises in regard to the breaking up of grassland. In other instances there

was reason to think that where farmers had broken up the desired amount of old grassland they had failed to break up the customary amount of rotation grass. To prevent a recurrence of this a large number of the Committees decided to make fuller use of their powers and to serve directions on every farmer. As a rule Committees did not stipulate the particular kind of crop to be grown except in the case of potatoes. In respect of mismanaged farms, the occupiers of which were working under supervision, Committees gave explicit instructions regarding the cultivation, manuring, drainage, etc., of land. Where occupiers for various reasons failed to carry out their directions it was decided that Committees should step in at an appropriate time, undertake the cultivation, procure the seed, manure, etc., sow and harvest the crop and recover the costs as quickly thereafter as possible.

Effect of Committees' Efforts.—Both directly and indirectly the effect of the exercise of their powers by Committees was most beneficial. A quarter of a century's neglect of drainage, particularly in cases where two or three parties were involved, had caused large areas of fertile land to become non-productive. The extent of the damage thus done was largely disclosed by the 1940 survey, and in many instances Committees were able to induce the interested parties to effect improvement without issuing explicit directions on the matter. In cases where a farm was being mismanaged the occupier was persuaded to place the general control of his farm under someone appointed by the Committee. Where financial circumstances prevented an occupier from complying with the formal directions of a Committee the Committee could, in quite a friendly spirit, enter upon the land and carry out the necessary work. By the wise use of their powers Committees were thus enabled to do a vast amount of useful work without creating a feeling that harsh treatment was being applied.

It was inevitable, however, that, in spite of the tact and forbearance shown by Committees, they would be forced in certain instances to adopt sterner measures. In all some 35 cases relating to the previous year's campaign were put forward for prosecution, and in 33 of these fines were inflicted.

Utilisation of Deer Forests for Grazing.—The encroachment of the plough on the grassland areas of the country makes it imperative to secure that the fullest possible use is made of the rough grazings available on deer forests. The Agricultural Executive Committees in the Highland districts were instructed, therefore, to take all necessary steps to this end. Where forest owners are willing to negotiate seasonal lets or leases to stock owners, which would result in full utilisation of the grazing capacities of the forests, Committees give all necessary help to

promote suitable arrangements. If the owners agree to accept any tenants found by them the Committees arrange for publicity to be given, where required, to such information as the exact location of available grazings, charges, shepherding arrangements, etc. In cases where satisfactory arrangements for stocking cannot be made in co-operation with any deer forest owner, the Committee may recommend the Secretary of State to take possession of the forest for the purpose of stocking it or of letting the grazings to suitable tenants.

During the autumn of 1940 the Secretary of State took possession of three deer forests covering a total area of some 91,300 acres. On two of these forests plans for the building up of a permanent sheep stock were put in hand and, as a first step, some 4,500 sheep were put on. Possession of one of these two forests was later given up, as the proprietor agreed to take over the stock put on and to carry out the plans already made for further development. The stocking of the forest of which possession has been retained has been further increased this spring. The third forest taken over provides some grazing for sheep on an adjoining sheep farm now also in the Secretary of State's possession. It will also be used for the summer grazing of other stock.

At the request of the Secretary of State members of the Scottish Land Court surveyed last summer most of the deer forests in Caithness, Sutherland, Ross and Cromarty, Western Inverness and North Argyll. These reports, which will form useful guides to Committees in their negotiations with forest owners, show, in the aggregate, the following:—

	No. of Forests.	Acreage.
(a) 1. Forests already fully stocked - -	7	119,000
2. Forests already in process of being fully stocked - - - - - - -	5	160,000
3. Forests where stocking is not practicable chiefly on account of altitude - -	3	44,325
4. Forests where permanent stocking is practicable - - - - - -	42	980,540
5. Forests where summering only is practicable - - - - -	15	249,695

	Sheep.		Cattle.	
	Permanent.	Summer only.	Permanent.	Summer only.
(b) Stock on forests at date of survey -	50,000	13,000	1,500	640
Immediate increase practicable -	32,130	26,350	450	1,660
	82,130	39,350	1,950	2,300

The reports indicate that, provided the number of deer were reduced and heather burning, draining and other improvements (*e.g.* building equipment) carried out, many of the forests could ultimately carry still larger numbers of sheep and cattle. These improvements would naturally be a gradual process requiring a period of years for completion. It is impracticable, in view of the nature of the subjects, to estimate reliably what the maximum carrying capacity might be; this could be determined only by actual test.

Government's Tractor Reserve.—In order to ensure that any farmer, who might experience difficulty in carrying out the necessary cultivation connected with increasing his tillage area, could carry out his work effectively, a Government reserve of tractors and equipment was created on the outbreak of war. It was intended that this reserve should be called upon only after it was found impossible for the farmer with his own machinery or with the aid of local contractors to carry out the work. In order to obtain the services of these tractors, etc., farmers who found themselves in difficulties as regards cultivations were asked to approach their local Agricultural Executive Committee who are responsible for organising the work to be done by the outfits in their areas. When Committees were satisfied that all local means of carrying out the work had been exhausted, steps were taken to get the work done by the Department's Tractor Section. In the spring of 1940 the fullest use was made of this service, and over 12,000 acres of land were ploughed and 22,000 acres of other cultivations undertaken. At harvest time the Department's binder outfits cut 27,000 acres, and the twenty-five threshing outfits available were subsequently used to capacity.

In 1941, owing to unfavourable weather conditions, cultivation work was at a standstill throughout January and February all over the country, and in some areas it was not possible to start work until April. In consequence there was a great rush to complete spring operations, and the Department's outfits, which were increased for the purpose, proved invaluable in helping to get the work done in time. Orders for the use of the outfits up to the end of May, 1941, amounted to 54,000 acres ploughing, and 68,000 acres of miscellaneous cultivations.

Agricultural Labour.—Although the farm labour force had been well conserved by the fixing of low ages of reservation from military service and by generous deferment of calling up, a fairly widespread shortage of skilled workers continued to be reported throughout 1940 and in the early months of this year. In particular areas the shortage was acute, the districts most severely affected being Easter Ross, Fife and the south-west dairying area.

Ploughmen, stockmen and dairy hands were in greatest demand. The Ministry of Labour and National Service were requested to take special measures to improve matters, but were handicapped in their efforts by the dearth of skilled hands and the unsuitability of most of the substitute labour available. It became more and more evident that, with the rapidly increasing strain placed upon the man power of the country to meet military and munitions needs, farmers, in common with employers in other industries, would have to make much greater use of substitute female labour than they had done previously.

The drift of workers from agriculture and other basic industries caused much concern and, in order to prevent it, the Minister of Labour and National Service made the Undertakings (Restriction on Engagement) Order in June, 1940. In addition to preventing workers from leaving agriculture, the Order makes provision for the return to the industry, when they become unemployed, of workers with previous agricultural experience. In cases where the provisions of the Order have been infringed, and in all other suitable cases in which key men have left agricultural employment, the Minister of Labour and National Service can issue directions to the men concerned to return to work on the land.

In order to provide the farmer with the additional labour he needed generally, and for carrying out maintenance, improvement, and reclamation work such as drainage, ditching, and bracken cutting, various expedients were devised last year. Among these was a scheme for the organisation by Agricultural Executive Committees of gangs of workers for hiring out to farmers. The gangs were to be employed by the Committee and accommodated in hostels. Practically no advantage was taken by Committees last year of this means of providing labour. The authority was originally given to Committees in respect of the summer months, but was subsequently extended indefinitely. There are signs that Committees are now realising the usefulness of gang labour, particularly for such work as land drainage. The Ross-shire Committee recently formed two gangs for this purpose and have in view the formation of further gangs. A number of other Committees have intimated their intention of utilising labour of this kind.

Other measures taken to secure an adequate supply of labour were the setting up of improved machinery for bringing workers from Eire to this country and allowing them to remain here indefinitely, and schemes for facilitating the temporary transfer to agriculture of roadmen and for the use of the services of interned aliens. Some 460 roadmen were reported to have been released last autumn for harvest work, but the number actually employed in agri-

culture may have been much in excess of this. Arrangements were made for placing with Scottish farmers 50 aliens who were interned in the Isle of Man and had some agricultural experience. In addition, the release from internment of other aliens previously employed by farmers was secured.

Supplementary Labour.—To help the farmer, particularly with the harvesting of his grain and potato crops, various schemes of supplementary labour were put into operation in 1940. Weather conditions during the summer and autumn proved especially favourable to the farmer for most of his seasonal operations. This factor, coupled with a greatly increased use of tractors, resulted in the demand for additional labour being smaller than had been expected. Nevertheless it is estimated that altogether about 3,000 volunteers helped the farmer last season under the Department's schemes. This figure is exclusive of the considerable number of volunteers who made private arrangements with farmers, casual workers from normal sources, and school children engaged on potato lifting. Some 250 of the older boys and girls at secondary schools worked from ten holiday farming camps. Six of the camps were set up in Perthshire, mainly for fruit picking purposes, while the boys from two in Angus and one each in Berwickshire and Midlothian were employed on general harvesting operations. At the request of Agricultural Executive Committees many Education Authorities adjusted the holiday periods of elementary schools to fit in with agricultural needs. So far as is known about 1,500 school children, mainly working in groups, were thus enabled to render assistance with harvesting, while in addition many thousands were able to help with the lifting of potatoes. One of the most successful of the supplementary labour schemes organised by the Department in conjunction with Committees was the Student Harvesting Scheme, under which over 400 students were placed individually on farms, and from all accounts gave satisfaction. In addition, a student camp was set up by the Agricultural Executive Committee for Inverness near Carrbridge. The Auxiliary Force of the Women's Land Army was recruited mainly from amongst students and teachers, who offered four weeks' service as a contribution to the national effort. Although enrolments numbered 1040, only 208 were placed in employment. That such little use was made of the scheme was due partly to lack of demand, and partly to the fact that in many cases the period of availability of individual volunteers did not coincide with the time when their services were most needed. For the potato harvest of 1940 some 80 Regular Force volunteers for whom permanent employment was not available were given seasonal work.

A considerable amount of harvest work was also performed by soldiers made available to farmers from local units. Ploughing and planting have been greatly helped by a further scheme for granting to farmers and farm workers in the Forces agricultural leave not exceeding 28 days in one or more periods up to 30th September, 1941, which was put into operation last November.

The Women's Land Army.—Some facts regarding the recent remarkable development of the Regular Force of the Women's Land Army in Scotland are of interest. During 1940 the number in regular employment increased from just over 100 in January to about 500 by autumn. This level was maintained throughout the winter months, thus tending to prove that farmers, though slow at first to realise the value of the Land Army as a source of supplementary labour, were in fact generally satisfied with the volunteers they obtained. On the whole, however, the rate of absorption in 1940 of the many hundreds of enrolled volunteers was below expectations, and it was not until March 1941 that farmers came forward in considerable numbers with requests for girls. By that time the number of trained volunteers available had dropped to a low level. About 450 volunteers—all equipped and mostly trained at State expense—had by then become lost to the Land Army, owing partly to the absence of permanent employment during the winter. New recruits had to be trained and equipped and, in consequence, those farmers who had not timeously notified their 1941 needs to their Agricultural Executive Committees had to wait for several weeks before trained volunteers were available. Since March, trained girls have been placed in employment at the rate of well over 50 each week, and by the end of May, 1941, the number in regular employment was about 950. In addition over 100 were training on the farms on which they were to be subsequently employed, and 80 were being trained at Agricultural College farms. The total number of those employed and in training was thus 1,130. The reserve of new recruits then waiting for training was about 350, and applications for enrolment were being received at the rate of nearly 600 a month.

The Future.—While recognising the vital importance of increased food production at home, the Government have decided that agriculture, like every other industry, should give up some more of its young men to the Armed Forces. With this end in view the age of reservation in the main occupational groups has been raised to 25, and a special scheme has been devised under which a small proportion of the men thus rendered liable for service will be released for the Forces. The preliminary examination of individual cases has been entrusted to the Agricultural Executive Committees. As a result, a considerable burden of extra work

has fallen on the Committees who, in addition, are charged with the work of organising the supplementary labour schemes referred to above, involving in some cases the control and accommodation of gang labour. Committees have therefore been advised to stengthen their existing organisation by the appointment of labour organisers and other necessary staff. To date 34 Committees have made such appointments jointly or severally or have the matter under consideration.

Feeding-Stuffs.—The difficulties of the first winter of war were successfully overcome, and the total livestock brought through to the grass season of 1940 varied but little from the numbers of the previous year, in spite of the rigours of one of the most severe winters of recent times. This was no doubt due to the existence of reserves of feeding-stuffs in merchants' and farmers' possession at the outbreak of war. The events in the various theatres of war in 1940 enforced still further drastic curtailments of imports, and it became apparent that some far-reaching rationing system would require to be set up for the distribution of available feeding-stuffs in such a way as to secure the order of priority laid down by the Government, viz., milk cows, cattle and sheep, pigs and poultry. Several rationing schemes had been examined before the war and in the first few months of hostilities, but, for one reason or another, they were discarded. During the latter part of the summer of 1940, however, the question was reopened and a Committee was appointed by the Agricultural Departments to examine the problem afresh. Their Report, which was accepted in principle, provided the basis for the scheme of rationing of feeding-stuffs which came into operation on 1st February, 1941. The Minister of Food directed that, after this date, certain feeding-stuffs could be purchased only by depositing the appropriate ration document with the supplying merchants. The scheme entailed the assessment of the yields of grain on every farm; for this purpose the Department assumed that farms produced the amounts accepted as the county average, but did not take into account the yields coming from increased cultivations. Allowances were made in the calculations for the amount of grain used on farms prior to 1st February, and farms were divided into two categories, viz., (1) those who were assessed as having produced more than was necessary, reckoned in grain yields, to supply their animals as shown in the 4th December return, and (2) those whose yields were insufficient. Farmers in the first category were called upon to dispose of their surplus grain, and were thereafter entitled to obtain ration coupons on a ton for ton basis for their further sales of grain, within the limits of their ration requirements in accordance with the scale of rations laid down in the scheme.

Farmers in the second category received ration coupons sufficient to enable them to purchase feeding-stuffs up to the rationing scale.

The scheme provides for appeals to Agricultural Executive Committees in cases of need, and affords methods of obtaining additional feeding-stuffs in respect of certain classes of animals, *e.g.* high-yielding milk herds. The Agricultural Executive Committees are charged with the task of assessing appeals, and the issue of coupons is centralised in the Department. Apart from minor adjustments, the first period of the scheme, *i.e.* February to April, passed with less trouble than many had predicted, although it was found necessary, in view of the supply position, to devalue the coupon unit from 1 cwt. to ½ cwt. during April. Steps were taken to avoid any devaluation affecting the dairy herds or making necessary further decreases in the numbers of pedigree stock and selected poultry flocks.

For the summer period farmers have been informed that they must depend to a very large extent on grazing, and have again been warned that the prospective diminution in supplies makes it imperative that they should make themselves as independent as possible of purchased feeding-stuffs.

From time to time it has been necessary to make special arrangements with the Ministry of Food for meeting emergency calls for feeding-stuffs in certain areas and circumstances.

Fertilisers.—Spring deliveries of artificial fertilisers in 1941 in the main proceeded normally, quantities ordered by farmers being considerably in excess of pre-war years. Fair quantities of potash, mainly in the form of muriate, were available for selected crops and for inclusion in compounds. Transport difficulties were responsible for a reduction in the amounts of basic slag obtained from English works, while difficulties of labour and air raid precautions at limeworks, as well as an increased demand for industrial purposes, somewhat reduced the quantities of lime available for agriculture.

Vegetable Production in Allotments and Private Gardens.—The Scottish Gardens and Allotments Committee continued their efforts to secure a substantial increase in the production of home-grown vegetables from allotments and private gardens.

The Committee set out to obtain 70,000 allotments in 1941, and it is gratifying to record that that object has been achieved, the actual figure being 70,170, of which Local Authorities have returned 48,600, Military, Naval and Air Force Units 10,500, Education Authorities 7,740, and Railway Companies 3,300. The return by Local Authorities is particularly satisfactory when it is recalled that the figure at the outbreak of war was only 18,000,

and the peak figure in the war of 1914-18 about 43,000. The total return for allotments represents an area of 3,700 acres under home-grown vegetables, which is a substantial contribution to the nation's larder. Forty-eight Local Authorities have reported that a total area of 867 acres in public parks has also been converted to vegetable growing this year.

The area in private gardens devoted to vegetable growing cannot, for obvious reasons, be accurately assessed, but sufficient information has been obtained to indicate that the contribution from this source will also be substantial.

In the attainment of their objective the Committee has been ably supported by its Area Leaders, the majority of whom are members of the Scottish Branch of the Institute of Park Administration, or of the Institution of Municipal and County Engineers in Scotland, while Local Authorities generally, impressed by the urgency and importance of the task in hand, have loyally co-operated. Excellent assistance was also given by the Agricultural Colleges, the Scottish Women's Rural Institutes, the Women's Voluntary Services for Civil Defence in Scotland, and many other willing workers.

A feature of the winter's programme was the exhibition of the colour film lent by Plant Protection Ltd., which depicted such cultural activities as the breaking-in of ground, soil preparation, the application of fertilisers and manures, sowing and planting, and storage of produce. The film was exhibited at 120 centres, and over 16,000 persons attended the meetings. The Committee's leaflets, which cover all phases of vegetable cultivation, have been in considerable demand, while the "Newsletter," 3,000 copies of which are distributed monthly, has served a useful purpose. Special activities this summer will include an Allotments Competition on a national basis, and a demonstration van, presented and equipped by Scottish Agricultural Industries Ltd., which will travel in selected districts.

There are at present 750 Allotments Associations on the Committee's Register, with a total of 56,250 members. The Committee's Outside Organisers are maintaining close contact with these bodies with a view to giving such guidance and assistance as may be required.

Allotment-holders and small growers have been advised to follow a system of orderly cropping, so planned as to ensure a succession of vegetables all the year round. To facilitate this, a special Seeds Collection was prepared and, by arrangement with the Horticultural Section of the Scottish Seed and Nursery Trade Association, was made available on advantageous terms to Associations registered with the Committee.

THE FUTURE OF BRITISH FOOD PRODUCTION.

Sir A. DANIEL HALL, K.C.B., F.R.S.

Is an increase advisable in the Output of Food from British Land?

THIS question can only seem futile at the present time when it is urgent that every farmer should put out his utmost strength to produce the maximum amount of food that can be got out of the land. We have, however, every confidence that the war will end in such a way as will leave our people with the power of determining what is to be the future of the land and what sort of farming shall be encouraged. A good deal of change is being effected in response to the situation; for example, in 1938 there were less than twelve million acres of arable land, but, if the directions of the Government get carried out, another four million acres, *i.e.* an increase of one-third, will have been added by the end of this summer. Are the farmers, when the war is over, going to be encouraged to maintain this extra production, or is farming, as at the close of the last war, going to be allowed to look out for itself and drop back into the sort of limited production that seemed to be most remunerative in the twenty years between the two wars? Not without reason do farmers look back with some foreboding to the promises that were so freely given about 1918—that in the future the welfare of agriculture should be one of the prime concerns of the State. Farmers declare that they were left in the lurch, or even stronger language is used. It will, however, be sufficient to say that the mass of the population, and we must remember that the agricultural community—farmers and labourers together with their families—amount to less than ten per cent. of the population, had again lapsed into unconsciousness that farming and farmers exist. The urban people may be full of goodwill towards farmers when their goodwill is asked for, but between whiles they just don't happen to think about agriculture, so foreign to their experience has the work upon the land become. If one mentions farming to a man of business his opinion generally will be that there is no money in it, as may be seen from the fact that it is not possible to float a company for farming in Great Britain. In some cases he may have read a little on the subject, and will put forward the argument that an increase in the output of agricultural commodities in this country is superfluous and, indeed, opposed to the best interests of the nation as a whole. He will recall the overproduction that was so much in evidence ten years or so ago, when attempts were being made to limit the output of wheat and sugar by international agreements, when surplus coffee was being burnt in Brazil and payments made in the U.S.A. for *not* raising hogs. The objectors to

agricultural development assert that the prosperity of Great Britain was founded on international trade; in return for the sale of manufactured goods to our Dominions or South America we have to receive payments in foodstuffs, which are the chief materials these countries are able to export. We have, again, financed these newer countries very freely, have built their railways, water works and electric lighting plant, and the interest on these loans can only be paid by the sale of foodstuffs in this country's markets. Mr Neville Chamberlain, when Prime Minister, put this position very clearly in a speech he made at Kettering in July, 1938, in which he stated that the manufacturing and industrial interests of the country must have priority in shaping the national policy. He went on to say that, if in some way we could intensify our agriculture so as to become self-supporting in matters of food, we should only succeed in ruining those Empire and foreign countries which are dependent upon the English market, and this would react upon our manufacturers who have to exchange half of their output for imports of food. In so far as we reduce the purchasing powers of those countries by growing our own food we should equally impair our vital industrial and financial position. The point of view thus set out by our late Prime Minister largely dictated the country's policy towards agriculture in the years before the war.

It will be recalled that at the Ottawa Conference it was agreed that, though Great Britain had the first preference in the home market for agricultural products, yet the Dominions were no less entitled to admission before any foreign country. British farmers have never been entirely satisfied at the way the Ottawa agreements were being implemented, and at a Conference of Empire Producers held at Sydney in 1938 an attempt was made to secure a joint basis of action shared between British and Empire producers. As far as can be gathered from the reports available, the British representatives agreed that, for commodities in which both parties were concerned, a pool should be set up in which the British share should be defined and limited, while the Dominion representatives agreed that the British quota might receive a special price, though it is not made clear how much of that price would come from the pool or from British subsidies, such as the then existing deficiency payments for wheat. Of course this agreement assumed that the concurrence of the Governments concerned could be obtained, particularly that the British Government would make a closed market in which the pool would operate both as regards the supplies to be purchased and the price to be charged to the consuming public. The subsequent declaration of the National Farmers' Unions would seem to indicate that farmers accepted the argument

expressed by the late Prime Minister that they must not expect an increased demand; instead they are aiming at securing a defined output at guaranteed prices which will be obtained by closing the market to competition and regulating supplies. This is the policy of "scarcity," based upon restricting supplies to the amount that the market will absorb at the price the producers consider adequate.

Before considering the expedience of such a policy and the reaction of the consuming public to it, one may enquire if the reasoning upon which it is founded is valid. The assumption is that the demand for any particular food commodity is inelastic, and that there is a saturation point of the market, any supply above which results in overproduction with its consequent break of prices in the free market. This may be true when consideration is confined to a single article; for example, the consumption of wheat in this country is about 300 lb. per head per annum, and we cannot suppose that more or cheaper wheat will induce our people to eat appreciably more bread. Poverty may do so, at the cost of reduced consumption of other foods, for it is a well-recognised fact that the poorer strata of the population eat the most bread because it is one of the cheapest essential foods they can buy.

But if we consider the whole range of foodstuffs there need be no fear of overproduction, because the principle of substitution comes into play. Wheat in a normal way is turned into bread, and this is its most efficient utilisation if we are considering only the gross amount of life-sustaining food that can be obtained from the wheat. But wheat can be fed to livestock and thus be converted into pork or eggs or milk, foods which are far from being consumed up to the saturation point. The only limit in practice to the demand for bacon is the ability of the population to buy it.

Thus any production of wheat that is surplus to the normal consumption in bread can immediately be disposed of by conversion into these secondary animal foods.

The essential feature of such a substitution is that in the conversion of wheat into animal food there is a considerable loss of essential food value. To make a pound of pork five pounds of wheat must be consumed, and the same or even a greater ratio exists between all the animal foods and the primary vegetable foods out of which they are manufactured. We have to measure food values in Calories in terms of energy supplied, and a man in active but light work must be supplied with foodstuffs yielding 3,400 Calories a day. Now five pounds of wheat will make five pounds of bread, which contain 5,200 Calories, whereas a pound of pork contains only 1,300 Calories. To live on bread alone a man would have to eat 3¼ lb. a day in order to get nearly his

3,400 Calories. But suppose he substituted half a pound of pork for some of the bread he would still have to eat a little more than 2½ lb. of bread in order to get his 3,400 Calories. In the first case, on bread alone, he would only be a consumer of 3¼ lb. of wheat, in the second case he would be consuming 2½ lb. of wheat as bread and another 2½ lb. as the raw material for his half-pound of pork. Though he eats less bread he still becomes a larger consumer of wheat; there never need be any surplus of wheat because the excess of what is in demand for bread can always be converted into pig or other animal products of which the potential demand is very far from being satisfied.

This broad principle of substitution holds not merely for wheat but for all the food products from the soil that may be consumed directly as human food or indirectly after conversion into animal food. The conversion always involves a loss of absolute food, a loss in the ratio of something between four to one and ten to one. The same principle holds good for all the higher forms of production even though they are not first converted by animals. Fruit and vegetables require much more labour to grow than wheat or oats but, though of great value dietetically, they do not contain as much energy as the cereals, so that they cannot be substituted for them, pound for pound. But the more the consuming public buys fruit and vegetables the greater will be the call upon the cultivators of the soil, since a complex product of the soil is being substituted for a simpler one. If in a family dietary a couple of pounds of carrots or kale are included they will only do the work as life-sustaining food of 2½ ounces of bread, so that the total requirements of the family from the farmers and the soil will have been considerably increased, and the diet will have been improved from the health-giving point of view.

The principle of substitution, then, depends upon abundance instead of scarcity of supplies; there cannot be, for example, overproduction of the cereals until the needs of the public for bacon and eggs and milk—to mention only three of the products into which cereals can be converted—are satisfied, a very remote contingency.

Now this may be a very handsome principle, the critic will object, but it will not work, simply because the bulk of the consuming public have not the money to buy the amount of bacon and eggs or of fruit and vegetables that they would like. People have to buy the primary foods, such as bread and oatmeal and potatoes, because the animal products of conversion are too dear; consequently, if we are to obviate overproduction by substitution, the secondary products of conversion must be made cheap.

Farmers consider that they must stand out for high prices but, with each increase of price, the amount that can be sold grows less, and the demand for the farmers' services is reduced. When

the time comes for a consideration of the policy the country should adopt for agriculture, it will be well to have in mind that a large cheap production, instead of a small output at high prices, is the alternative that makes the greater use of farmers and extends their business. In so far as the farming industry can go out for quality foods as a means of disposing of extra quantity it will be strengthening its position in the national economy, whereas a much impoverished people will be apt to look coldly upon the policy that was being advocated before the war, of a limited output for which the Government will guarantee good prices. For the same reason it will always be worth considering how far State assistance to agriculture should be directed towards cheapening to the public the higher kinds of agricultural production, subsidising eggs and bacon, fruit and vegetables, rather than wheat or sugar, because the former are the commodities which provide the greatest amount of employment for the agricultural community, and for the production of which farmers are most indispensable. This, however, is no place for a discussion of policy, but when the occasion comes it should be realised that overproduction in agriculture is not an inevitable consequence of extending cultivation, but can always be evaded by utilising substitution.

But to return to the starting point of these reflections—is there any room for a progressive agriculture in this country, or must we accept the argument of the industrialists that they need the food market for their customers who have no other means of paying for our manufactures? To begin with, we may ask the industrialists and financiers if they remain so confident that payments will still have to be made either for investments or for our goods. How much of the capital that was laid out overseas in railways, harbour works, electric undertakings and so forth is likely to be left in British hands when this war of destruction is over, how willing or able will other peoples be to buy British? The old economy on which the prosperity of Britain was built up in the previous century depended upon freedom of international trade; it was impaired before this war began. Even if it can be restored time will be needed to convince the nations that their game of shutting out the foreigner is the way to poverty. Our manufacturers will have to cultivate the internal market and get from our farmers the food they need in exchange for the goods they produce.

Quantitatively the case for farming in the British national organisation depends upon its efficiency; how far does its output per man engaged show it to be a reasonable business proposition compared with the performance of the other major industries? Now, if we merely look at the fact that in the years immediately

before the war farming, with its gross output of £265 millions, was yet depending upon subsidies from the State which directly and indirectly amounted to over £40 millions a year, it seems to make a poor showing. But examination of farmers' accounts, such as are available from the financial survey that is being undertaken by the agricultural economic advisers, shows that reasonably competent farmers, not merely the exceptional ones, were obtaining a gross return of between £300 and £400 per man employed, which compares favourably with the results obtained by other industries.

It was the dead weight of the neglected, impoverished and underfarmed land of the country that brought down the general average so low. The renovation of so much of the derelict farming land that the War Agricultural Committees are now effecting may be taken as an earnest of a new policy that will choose increased production by extending good farming over the whole agricultural area, instead of a restricted output only economic on a moiety of the cultivated land.

Looked at from this point of view it scarcely seems necessary to enter upon any detailed economic enquiry as to whether British agriculture will be worth while, whether, in fact, it can progress and extend its output without harm to the industrial interests. In the land the nation possesses a great estate, though no inconsiderable part of it is neglected and working only at half power; it cannot be uneconomic to repair the waste that is going on. The land will require some, but no excessive, capital outlay, and it will not only support its cultivators, but also will yield a divisible surplus by which the community is the richer.

After the destruction wrought by this war the nation will have to live on the immediate products of its industry, and no production is more immediate, nor more truly wealth, than that which arises from the organised application of labour to the land.

STOCK-FEEDING UNDER WAR CONDITIONS.

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SCOTLAND has always been pre-eminently a stock-rearing and stock-feeding country, and the big problem facing farmers to-day is how to maintain their herds of cattle and produce meat in these days of scarcity of imported feeding-stuffs. The introduction of the rationing scheme in February, 1941, and the devaluation of the coupon unit from 1 cwt. to ½ cwt. in April, afford ample testimony of the real gravity of the situation.

Tremendous strides have been made since the end of the last war in the rationing and feeding of stock, and it is true to say that the great majority of farmers have now a sound knowledge of this subject. In particular, in order to meet the public taste for smaller joints, farmers had effectively modified the system of rearing and feeding cattle, and up to the outbreak of war there had been for some years a continued and progressive tendency to fatten off at earlier ages. This was evident from the increasing difficulty of procuring store cattle of two years of age or over capable of being fattened for the most part on the home-grown foods of the farm. The fattening at younger ages necessitates a more lavish use of concentrates in the daily ration.

One inevitable result of the present shortage of cattle feeding-stuffs would therefore seem to be that our system of rearing and feeding must be modified in the direction of not attempting to fatten off at quite such early ages. Cattle that ordinarily might have been fattened between the ages of 18 months and 2 years may now have to be carried forward as stores for an additional 6 months and fattened between the ages of 2 and 3 years.

Before the war, in the days of abundant and cheap imported concentrates, if home-grown foods got a little short the farmer did not worry, but simply bought and fed some cake or meal. Now that has all been changed and much more careful planning must be made in order to have the requisite quantities of home-grown foods.

The position then is that we must try to rear our stock as far as possible and bring them to a reasonable state of fatness for slaughter on home-grown foods. The same applies to the production of milk, even though the dairy cow has been given preference in the allocation of the feeding-stuffs that are available. In this article an attempt is made to suggest rations, consisting as far as possible of home-grown foods, for the various classes of cattle stocks. Where, for the sake of obtaining a balanced ration for some particular purpose, imported foods are included, the amount is small.

Calf Rearing.—Except in the case of the beef breeds, where the calves are reared by the natural method of suckling their dams until 7, 8, or 9 months old, pail feeding is generally practised. Under this system before the war a common practice was to feed an average of one gallon of milk per day for the first three months. Thus a total of about 90 gallons was required to the weaning stage. The writer is one of those who thought such practice sound and economical in spite of all that has been written about the saving that may be effected by using substitutes for whole milk. Where substitution is adopted, the quantity of milk is often

reduced from, say, 90 to about 45 gallons, effecting a saving of 45 gallons. The average net price of milk in the area of the Scottish Milk Marketing Board for the last three or four years before the war may be taken at about 10d. per gallon. The value of forty-five gallons at 10d. is £1 17s. 6d. From this saving of £1 17s. 6d. there falls to be deducted the cost of the substitutes used. Further, there should be taken into account the lesser rate of live-weight increase and greater risk of calf ailments. When all the foregoing are reckoned up the saving (if any) effected is indeed a meagre one.

But with the present-day need to sell every possible gallon of milk for human food, there is more to be said in favour of using milk substitutes in calf rearing. Of such methods, probably the one that has been attended with the best results, and which has the merit of being simple and easy to carry out in practice, is that where a suitable mixture of concentrates fed dry replaces the whole milk. The procedure is as follows:—For the first four weeks one gallon of milk per day should be fed. At the age of 3 weeks the calves should be given a little concentrates and good quality hay to nibble at. During the second month the concentrates should be gradually increased by ¼ to ½ lb. each week and the milk reduced by ¼ gallon. Thus, by the end of the eighth week the milk is entirely withdrawn, its place having been taken by about 2 lb. concentrates. As the milk is reduced it should be replaced by a rather larger quantity of water. By the time all the milk is dispensed with a calf should be given one gallon of water twice daily. During the winter months the water should be slightly warmed, otherwise the youngsters may not drink a sufficient quantity. This is a very important item for the well-being of the calf.

Suitable mixtures of concentrates are by weight:—

(A)		(B)	
Oats - -	6 parts.	Oats - -	4 parts.
Linseed Cake -	3 parts.	Bran - -	2 parts.
White Fish Meal	1 part.	Linseed Cake -	2 parts.
		Kibbled Locust -	1 part.
		White Fish Meal	1 part.

Turnips cut into finger lengths should be fed along with the concentrates. Until 6 months old the allowance of concentrates may be maintained at about 2 lb. daily, and hay given according to appetite. If, however, rapid progress is desired, up to 3 or even 4 lb. concentrates per day may be fed, but reasonable progress will be assured with a total of 2 lb. daily.

A second method is to feed milk substitutes in the form of gruel. This may be introduced into the ration at the age of 10 days; thereafter the milk is gradually replaced by a whole-milk

substitute. One substitute which has given good results is composed of equal parts of dried milk powder, oatmeal, linseed cake meal and fine thirds. There are a number of proprietary milk substitutes on the market. Under the Livestock Rationing Scheme an allowance of 42 lb. per month for each calf under 6 months of age may be obtained on application to the Agricultural Executive Committee. The coupons issued for this purpose are valid only for calf meals or gruel, dried milk powder or National cattle food No. 3 (rearing compound).

On farms where the milk is not sold the semi-natural or intensive suckling method is sometimes adopted. In this system one cow may rear a number of calves during a lactation. Two, or with heavy milking cows, three or even four calves may be put on to one cow. After 10 or 12 weeks two fresh calves are introduced and the first lot is gradually weaned. By the time the second lot is ready for weaning, the cow will be going down in her milk yield, and one calf may be put on for the remaining period of the lactation. This method avoids the trouble involved in milking, the calves thrive well, and from 5 to 8 or even more calves may be reared per annum by one cow. With this system, as with pail rearing, it is important that the calves be accustomed to the eating of concentrates and hay for some weeks before weaning, so that at the weaning stage no arrestment in progress occurs. From weaning till 6 months old the feeding is the same as that already described for pail-fed calves.

When the age of 6 months has been reached the fish meal may be cut out of the concentrate mixture and replaced by a cheaper protein-rich food such as ground nut cake; although if supplies are available there is perhaps nothing more conducive to health and steady progress than the inclusion of, say, ¼ lb. fish meal daily. Calves born in the spring may be turned out to grass when they are 10 to 12 weeks old. Good grass being more nutritious than hay, the amount of concentrates may be reduced. From the age of 6 months, when on pasture, concentrates may be entirely withheld.

During the winter period, when housed at night and given an outrun on pasture during the day, the following rations are suitable for animals from 6 to 12 months:—

Good Hay - - -	6 lb.
Sliced Roots - -	14 lb.
Concentrates - -	2 lb.

The concentrates may be replaced by about 10 lb. of good silage. The concentrates (or silage) may be kept constant in amount, but the quantity of hay and roots should be increased to keep pace with live-weight increase. In all the following rations hay of good

quality is assumed; if the hay is weathered in the making, or over-ripe when cut, a little extra concentrate, say, 1 lb. linseed cake, should be given.

Store Cattle.—From the age of 12 months (weight 4½-5 cwt.) concentrates may be withheld from store animals, as any available can probably be used to better purpose in the later stages of fattening. Also, from the age of 12 months onwards, half of the fodder may be given as oat straw, but extra roots should be provided to make up for the lower food value of straw compared with hay. The following are suitable:—

(1)		(2)	
Hay	8 lb.	Straw	7 lb.
Straw	4 lb.	Swedes	28 lb.
Swedes	40 lb.	Grass Silage	15 lb.
		Oats	2 lb.

For cattle 18 months, weighing 6 to 7 cwt:—

(1)		(2)	
Hay	8 lb.	Straw	10 lb.
Oat Straw	6 lb.	Swedes	60 lb.
Swedes	56 lb.	Grass Silage	15 lb.

For two-year-old stores, weighing, say, 7½ to 8 cwt.:—

(1)		(2)		(3)
Hay	12 lb.	Straw	15 lb.	Turnip, ¾ to 1 cwt.
Oat Straw	6 lb.	Swedes	70 lb.	Straw, *ad lib.*
Swedes	60 lb.	Grass Silage	20 lb.	

All the foregoing rations for young store cattle should, with a run on grass during the day, give a live-weight increase of about 7 lb. per week. During periods when the ground is under snow or frost bound, and no sustenance can be got from the pastures, a little extra hay should be fed.

The Fattening of Cattle.—In the earlier stages of fattening reasonable progress should be secured where the ration fed is somewhat similar to that for good stores, but a more generous allowance given. As fattening proceeds, however, and live weight increases, the extra nutriments needed cannot all be obtained from roughages because the bulk that would be required is beyond the appetite of the animal. Therefore some food of higher energy value and lower in fibre content must be given. This may be attained by substituting swedes for turnips, by reducing the quantity of straw and giving some hay, by including concentrates in the ration and, in the final stages, seeing to it that the concentrates themselves are of high energy value, such as maize and linseed cake, rather than, for instance, undecorticated

cotton cake. But such refinements in the choice of concentrates are not likely to be attainable in these days of scarcity. The inevitable consequence is a lengthening of the fattening period, or the marketing of animals for slaughter before the wonted high degree of finish has been attained.

Full-grown cattle during fattening are capable of consuming up to 1 cwt. roots daily, and at one time it was not uncommon to find such large quantities of roots, with straw according to appetite, being fed. Actually if to such a ration is added 1½ or 2 lb. of a protein-rich cake, such as decorticated ground nut cake or decorticated cotton cake or soya bean cake, reasonable progress should be made. In the last stages of fattening, however, when the animal's appetite for bulky fibrous foods diminishes, a supplement of, say, 1 lb. linseed cake and 2 or 3 lb. oats or maize meal should be fed.

Towards the end of the last war, in the winter of 1917-18, when concentrates were scarce, the West of Scotland Agricultural College carried out a feeding trial at the Crichton Farm, Dumfries. The results were reported in the "Transactions" of the Highland and Agricultural Society of 1920. The cattle used were well-bred Aberdeen-Angus crosses and Red Poll crosses. The average age at the commencement of the experiment was 21 months, and the average live weight 6 cwt. 2 qrs. 11 lb. Three rations were compared. The first consisted of 72 lb. swedes and straw according to appetite. A weekly live-weight gain of 10·9 lb. was obtained, but progress on this ration was not sufficiently rapid to allow of its being regarded as a suitable fattening ration, though satisfactory for store cattle.

The second ration was hay 6 lb., roots 72 lb., straw and water *ad lib.* The inclusion of 6 lb. hay gave much more satisfactory progress, the animals making a live-weight gain of 14·4 lb. weekly.

The third lot were given the same ration of hay and roots, with straw according to appetite, as in the second group, but in addition 3½ lb. concentrates, consisting of equal parts bruised oats and decorticated cotton cake, were fed. On this ration the rate of progress was further accelerated to 19·8 lb. weekly. Thus, on a ration where the only bought concentrates consisted of less than 2 lb. decorticated cotton cake per head daily, entirely satisfactory progress was obtained.

These results demonstrate the great value of hay and of feeding even a small quantity of concentrates if the most economical use is to be made of home-grown foods such as straw and roots.

The following rations for fattening, composed for the most part of home-grown foods, should give a live-weight increase of

14 lb. weekly. Thus, over a fattening period of 20 weeks, an increase of 2½ cwt. should be obtained.

As fattening proceeds the quantity of food should be gradually increased to keep pace with the live-weight increase. A rough guide is to increase the concentrates by ½ lb. every fortnight and the roots by 6 lb. every four weeks.

For brevity, the fattening period is divided into two—referred to as the first and final periods.

The rations listed may be taken as the quantities required at the beginning of the first and final periods respectively.

FIRST PERIOD—WEIGHT, 8-9½ CWT.

(1)		(2)		(3)	
Hay - -	8 lb.	Hay - -	6 lb.	Turnips -	80 lb.
Oat Straw -	10 lb.	Oat Straw	6 lb.	Oat Straw -	14 lb.
Marrow Stem Kale	56 lb.	Arable Silage -	50 lb.	Decorticated Ground Nut Cake	2 lb.
Bruised Oats -	2 lb.	Bruised Oats -	1 lb.	Bruised Oats -	2 lb.
		Palm Kernel Cake -	1 lb.		

FINAL PERIOD—WEIGHT, 9½-11 CWT.

(1)		(2)		(3)	
Hay - -	12 lb.	Hay - -	8 lb.	Hay - -	6 lb.
Straw -	10 lb.	Straw -	4 lb.	Oat Straw	10 lb.
Swedes -	56 lb.	Arable Silage	50 lb.	Swedes -	100 lb.
Oats - -	6 lb.	Linseed Cake	1 lb.	Palm Kernel Cake -	1½ lb.
or		Maize -	1 lb.	Bruised Oats -	2 lb.
1 lb. D.G.N.C.[1]		Bruised Oats	2 lb.		
4 lb. Dried Sugar Beet Pulp.					

The rations suggested in column (1) are suitable for a mixed farm where hay and a moderate supply of roots are available. Those in column (2) are for a farm where the soil is of a heavy nature and an arable silage crop is more easily grown than roots. The rations in column (3) would fit an arable farm where roots and straw are plentiful but only a little hay available, which can be economically used in the final stages. Where no hay is available, but some grass silage or aftermath silage has been made, the following would be suitable for the final period:—

Roots 80 lb., Straw 12 lb., Grass Silage 24 lb., Bruised Oats 2 lb.

While in the foregoing rations weights of straw are stated, in practice, animals would be given sufficient to satisfy their

[1] Decorticated Ground Nut Cake.

appetite. The amounts stated, however, will be found to approximate fairly closely to the actual consumption. All animals should be accustomed to roots on pasture before being put inside for fattening.

Dairy Cattle.—The feeding of the dairy cow under war conditions has not, so far, presented quite the same difficulties as has that of most other classes of stock because she has been given priority in the matter of concentrated feeding-stuffs. In the scheme of winter rationing put into operation at 1st February, provision was made for the supply of concentrates to the extent of $3\frac{3}{4}$ lb. for each cow in a dairy herd. When the average milk yield for all cows either in milk or dry exceeded $1\frac{1}{2}$ gallons, concentrates for the excess could be obtained to the extent of $3\frac{1}{2}$ lb. per gallon by making application to the County Agricultural Executive Committee. In all the suggested rations which follow, the amount of concentrates included are well within this limit. What the position may be next autumn and winter no one can foretell, but, with the extra acreages under the plough, there seems no reason why there should be any shortage of fodder or roots. The making of grass silage should go a long way towards mitigating any shortage of imported concentrates.

COW OF AVERAGE WEIGHT—9 CWT.

Maintenance plus 1 gallon of milk.

(1)	(2)	(3)
12 lb. hay.	6 lb. hay.	15 lb. hay.
8 lb. straw.	12 lb. straw.	35 lb. marrow stem kale.
40 lb. swedes.	20 lb. swedes.	
1 lb. oats.	20 lb. grass silage.	
$\frac{1}{2}$ lb. decorticated ground nut cake.	$1\frac{1}{2}$ lb. oats.	

(4)

22 lb. hay.

Maintenance plus 2 gallons of milk.

(1)	(2)	(3)
12 lb. hay.	6 lb. hay.	15 lb. hay.
6 lb. straw.	12 lb. straw.	35 lb. kale.
40 lb. swedes.	20 lb. swedes.	3 lb. oats.
1 lb. white fish meal.	20 lb. grass silage.	1 lb. decorticated ground nut cake.
4 lb. oats.	3 lb. oats.	
	2 lb. linseed cake.	

(4)

17 lb. hay.
40 lb. grass silage.

The following are typical mixtures for the production of one gallon of milk of average quality, and are composed either of home-grown crops or feeding-stuffs which were in reasonable supply in the winter and spring of 1941.

(1)	(2)	(3)
2 parts beans.	1 part white fish meal.	1 part decorticated ground nut cake.
3 parts crushed oats.	1 part palm kernel cake.	1½ parts crushed oats.
	3 parts oats.	1½ parts maize meal.
	2 parts dried sugar beet pulp.	

Number (1) should be fed at the rate of 4 lb per gallon of milk, and numbers (2) and (3) at the rate of 3½ lb. per gallon of milk.

It is always well to allow the milk cow a dry period of about 2 months before each calving. During this period something more than a maintenance ration is required to bring her into a fit condition at calving time and to provide for the unborn calf. A ration for maintenance and 1 gallon of milk just about fits the bill, provided it contains some foods rich in minerals and vitamins. Good quality hay, fish meal, linseed cake, bran and oats are suitable. If down in condition, a dry in-calf cow may require a further allowance of 3 or 4 lb concentrates or 20 lb grass silage.

Some Home-Grown Foods.

Succulent foods such as turnips, kale and silage have, apart from their nutrient value, a health-giving effect on stock. The dry matter content of each of these foods is a fairly reliable guide to its relative food value. Taking 20 lb. swedes as a basis, the following are replacement quantities:—

Swedes -	- 20 lb	Marrow Stem Kale	- 16 lb
Turnips	- 27 lb.	Thousand-headed Kale -	15 lb.
Mangels	- 18 lb.	Potatoes - -	- 10 lb.
Cabbages	- 18 lb.	Silage (Oats and Vetch)	7 lb.

It should be noted, however, that marrow stem kale, thousand-headed kale and cabbages contain about double the amount of protein in swedes and about three times that in turnips and mangels Thus when kale is used as a substitute for turnips or swedes, less protein from other sources is required in the ration.

Marrow stem kale is best utilised during October, November and December. After Christmas it becomes more fibrous and less palatable and is liable to suffer from severe frost. With proper manuring and cultivation a yield of from 20-30 tons per acre should be obtained. Forty pounds kale supplies sufficient protein for 1 gallon of milk. One acre of a 24-ton crop provides sufficient protein for 1,400 gallons of milk. Fed at the rate of 40 lb. daily, a 24-ton crop provides kale for 14 or 15 cows for three months.

Thousand-headed kale, while seldom yielding quite so heavy a tonnage per acre as marrow stem kale, can be relied on to produce a large amount of nutritious food. It is hardy and can stand a severe winter without damage, and may therefore form a useful source of green food after Christmas

Swedes might contribute more than they do at present to the rations of cattle in the spring months. There are two points worthy of special attention. The first is the marked effect which the application of boron to the soil has on the keeping quality; the second is that for use in March and April, swedes keep much better when ploughed in than when stored in clamps and pits. In spite of the severe frosts experienced in January and February, 1941, swedes stored in this way were being used, sound, fresh and succulent right up to the beginning of May.

Potatoes, surplus to human needs (and there were considerable quantities available in the spring of 1941), may be included in the rations of fattening cattle or milk cows, and may be substituted for turnips or swedes on a dry matter basis. On the average potatoes contain about 24 per cent. dry matter as against about 11 per cent. in swedes and 8.5 per cent. in turnips. Twenty lb. potatoes will supply approximately the same amount of dry matter as 40 lb. of swedes. In an experiment carried out at Auchincruive some years ago, where potatoes replaced swedes in the ration of fattening bullocks, the live-weight increase of the group receiving potatoes averaged 14⅝ lb. per week as against 13¼ lb. in the group receiving swedes. The quantity of potatoes fed was 40 lb. daily. This would seem to indicate that potatoes are as good as swedes for beef production. Potatoes may be fed whole, but should be reasonably clean and free from soil. To this end they should be screened or riddled when dry to remove any soil adhering to them. Diseased or partially rotted potatoes should not be fed to stock. The same is true of potatoes which have been "greened" and which contain "Solanin," which is of a poisonous nature. For a like reason, potatoes which have sprouted should have the sprouts broken off before feeding. Raw potatoes are slightly

laxative, and only a small quantity should be fed at first, and then the amount gradually increased to the desired maximum.

Hay.—The merits of good quality hay as a source of protein should not be overlooked. The experiment at Crichton already referred to clearly demonstrates this. There is perhaps no other crop which varies so much in its nutrient value. The important thing is to cut the crop in good time before the nutrients pass from the leaf and stem into the seed, which begins to take place as soon as the " flower " or pollen disappears. A second advantage of early cutting is that a more robust growth and greater bulk of aftermath is obtained. This aftermath provides excellent grazing in the autumn when pastures begin to fail, or it may be converted into silage to take the place of concentrates in winter.

Chaff, which is obtained from the threshing of cereals, if free from mould and dirt, is a useful food and well worth storing and feeding to stock. As a rule, chaff has quite as high or even a higher feeding value than the straw from which it comes. The chaff of oats is better suited to stock feeding than either barley or wheat. A few pounds fed daily may take the place of rather more than its own weight of straw, and can probably be fed to more advantage to store or young animals than to milk cows or bullocks actually being fattened. If it is moistened with treacle water stock will consume it readily.

Grass Silage.—So much has been written and spoken about grass silage during the last eighteen months that the briefest reference to it should suffice. It is a food that varies much in composition, according to the stage of growth at which the grass is cut and other factors, but, generally speaking, 5 or 6 lb. of good molassed grass silage (or aftermath silage) should replace 1 lb. of a balanced concentrate. It is an excellent and palatable food, rich in minerals and vitamins. Fed to dairy cows it helps to keep up the rich yellow colour of milk. There is evidence that the feeding of silage to in-calf cows has a beneficial effect on the health of the new-born calf, and that much less illness and trouble is experienced among calves born in the late winter and early spring. These defects had often been attributed to the lack of something in the indoor winter rations in comparison with grass.

A final recommendation to all farmers who are to have cattle stocks in the winter producing either milk or beef is to see to it that they have a reserve of grass silage. Other than dried grass, it is *the* home-grown food which holds out most promise of replacing purchased concentrates. A great advantage of silage is that, if properly made, it will keep for a year or two, and is therefore available for feeding at any time throughout the year when concentrates are not procurable.

WASTE ON FARMS.

Major JAMES KEITH, of Pitmedden.

ONE'S first reaction to the question "How can one prevent waste on farms?" is to reply: "There is no waste on Scots farms; everything is taken care of and the utmost economy practised everywhere."

Taking a wide view, however, a good many instances come to mind on one's own farm and elsewhere where there is waste, in one sense or another.

It is frequently pointed out by the uninformed that many tools on the farm are not used to anything like their capacity, and that, by co-operation, more use could be made of them. For instance, a tractor on a 150-acre farm can work only some 30 to 40 days and must stand idle the major part of the year. The same applies to almost every tool on the farm, but, except to a very limited extent, it is inevitable, as the amount of time available for many operations in Scotland is so limited that the only hope of success is to have a complete plant available on the spot to take advantage of the fleeting opportunity. In the main, therefore, we may rule out that as a form of waste prevention.

Another criticism regarding implements on most farms is lack of care. I think it was pointed out in a recent article in this Journal that the chief reason why implements are left standing out uncared for is the simple fact that not one farm in twenty has any proper implement shed into which implements can be easily drawn, when not in use, to be overhauled and cleaned conveniently, with the result that binders, manure distributors, corn drills, etc., are left outside deteriorating. Our farm buildings are mainly based on 1870 ideas, when the only implement on the farm which could deteriorate much was a cart, and a cartshed was always provided, but now, when we have a multitude of complicated and expensive machinery, no proper provision seems to be generally made for its care. The reason for this is partly lack of imagination; very few farmers or landlords visualise what is required, but more often it is lack of capital, and into this enters the question of taxation. If a landlord erects such a shed at interest he is taxed on the interest and not allowed depreciation on the cost, although an implement shed will always be of the more or less non-permanent class. It would always be better for a tenant to subscribe a substantial part of the cost rather than to pay interest; this might be in the form of instalments over a period of years, if a sum down was not convenient.

At the same time, every effort should be made just now to prevent damage to implements. Spare parts and replacements are

difficult to obtain, and the fewer one needs the less likely are one's own efforts, and those of others, to be held up by shortages.

Loss of time is possibly the greatest waste on the farm. It takes many forms, some unpreventable through weather, others through the use of out-of-date tools, especially ploughs. I have just watched the ploughing of a field of lea by an old-fashioned high-cutting swing plough, the furrows average 7½ to 8 inches wide. To plough an acre with this means travelling 23,240 yards, or well over 13 miles, as against half the distance with an up-to-date plough turning a 15-inch furrow, which it will do with no more draught on the horses.

The cultivation of small arable fields is a notorious waste of time. Careful calculation shows that ploughing four 15-acre fields as against one 60-acre field means a loss of up to 25 per cent. of time. Ploughing round by tractor from the centre involves 120 yards of empty running each round in making the necessary circle at the corners.

Setting out all feerings in a field by one plough, and leaving all finishing to be done in the same way, saves an infinity of time in tinkering and adjusting of ploughs, and—perhaps it is too delicate a subject to enlarge on—but how many farmers or ploughmen consider how much time is lost daily by standing at ends, and are the proper number of lineal yards ploughed each yoking?

Horse tools are pretty well adjusted to the horse power, and tractor implements are becoming so, but one does see an immense amount of wasted time and effort through a 20 h p tractor pulling a two-horse tool. No doubt this will adjust itself in time. A vital and important thing is to see that all tools and implements are in order and ready for work when required. I expect most farmers have seen delay and loss caused by a drill, a manure sower, or a binder having been put away and neglected, and not being fit for work when required, or the tractor having its valves ground when it is required for the binder.

Vermin are probably the next greatest cause of waste on farms. Rabbits I need scarcely mention. A few carefully conducted experiments by fencing sections of crop where there are even a few rabbits, and comparing them with unfenced portions, would open the eyes of many who think no serious damage is done. I have in my occupation a light land farm of 450 acres which was so badly infested with rabbits that it rendered the tenant bankrupt and the land derelict. After it had been thoroughly wired, and the rabbits killed by gassing, it has done well and produced good crops each year.

Hares are also a serious nuisance in some districts, and are specially destructive of sugar beet and mangels. In dry weather a thirsty hare will cut off a score of beets or mangels to slake its

thirst, and then as many more for the fun of the thing. They also cause serious loss in swedes by chipping great numbers, which afterwards decay. They are easily killed off by a hare drive in February or March.

Rooks are wasteful and destructive beyond words in many districts. I know they do some good, if restricted in numbers, but, if some of those benevolent people who write to the papers of their benefits, had only tried to grow early potatoes near a large rookery, they would have to remain for ever silent if they have any regard for their chances in the next world. The worst of it is that scaring these pests does no real good; it only drives them on to one's neighbour's land.

The same applies to pigeons, but they are a more difficult subject as many come from abroad. They have, however, the merit of being eatable, and a small inducement to some fellow with a taste for shooting to become an expert decoy shot will very quickly reduce the numbers to reasonable proportions in any district. The art is not difficult, but once seeing it done by an expert is worth any amount of written instruction—it is no use waiting for Providence or the County Council to do it.

Moles are a serious nuisance on many farms. Apart from the actual damage they do in clean land corn and in turnip drills, uprooting whole stretches of young turnip plants, their hills cause serious damage to mowing machines and waste of time in hay fields, and, where stone drains exist, they are the main cause of trouble. Some of the benevolent busybodies say they are the farmer's friend, and that they eat the grub and wireworm. They may, but their main food is the beneficent earth worm, and nothing can be said in their favour. They are wholly destructive and obstructionist, and quite out of place on a farm, except in the form of a moleskin waistcoat.

Rats and mice also cause terrible waste, but they are not difficult to deal with by anyone who really means business. Poison and some traps will get them down, and cement and broken glass will make their return difficult, while a few cats about the buildings will make a serious reinvasion unlikely. Unfortunately, hardly any farms have a proper rat-proof storage for corn or feeding-stuffs, and the waste of sacks and bags is terrible. With sacks and bags at present prices the cost of making a loft or store rat-proof will be repaid in no time, and a rat-proof chest to hold a week's supply of meal in a byre or cowhouse will repay itself quickly.

Starlings and sparrows do a vast deal of damage, the former particularly on young wheat, but I don't know how to deal with them. They are migratory from the Continent and apparently cannot be poisoned. The best that can be done is to keep them on the move, so that they don't completely destroy any part of

the crop. Except near towns sparrows are local, and destruction of their nests by small boys will keep them in check on any particular farm.

There are a good many insect pests and diseases which cause untold waste on farms, and which can fairly easily be dealt with. The treatment of oat seed with Ceresan or similar compound saves from one to two bushels of seed per acre, and almost invariably gives a better and more uniform braird, and a careful watch on lea oats and the application of Paris green will prevent serious wastage through thinning by leather jacket grubs. Rolling with a heavy roller will frequently mitigate the attacks of wireworm.

Spraying or dusting of potatoes with a copper compound during growth, and cutting down the stems by sulphuric acid at any sign of blight, will prevent disaster and waste of valuable food, and, where fields are infested with charlock or other annual weeds, spraying with copper sulphate or sulphuric acid will kill the weeds, increase the crop, and, by preventing seeding, save future crops being damaged by these weeds.

Serious loss and waste on farms are caused by animal diseases such as abortion, sterility, and mastitis, and some other obscure diseases in cows which so affect dairy herds that cows rarely outlast three lactations in a commercial dairy. If they are introduced as heifers they mostly go out before they come to their best years, which are the third to sixth lactations. The cost of and loss from this is fabulous, and any Government which wants cheap milk must tackle it—it certainly adds 3d. to 4d. per gallon to the cost of milk. It also floods the market with cow beef and, possibly worst of all, makes the improvement of herds a slow process, because the best cows do not produce enough calves and a stock of inferior animals has to be kept. It is too big a subject even to outline here, but the waste caused on the farm by it is colossal.

The same applies to diseases of horses, sheep, pigs, and poultry, or even bees.

A considerable amount of waste goes on in feeding-stuffs, but scarcity and rationing will prevent that during the war, and the experience gained will likely educate users and prevent the wasteful use of cake and meal in the feeding of cattle and sheep in future. But another aspect must be considered, the waste involved in killing immature stock. A half-fat bullock will kill 52 per cent., while, by keeping him two months, he will gain 2 lbs. daily and probably kill 58 per cent. This works out as follows:—

	1100 lbs. at 52 per cent. = 572	carcase weight.
60 days of 2 lbs.	120	
	1220 lbs. at 58 per cent. = 707½	carcase weight.

The increase in dead weight is 135 lbs., or 15 lbs. more than the live weight increase, surely a strong argument for maturing cattle reasonably and not slaughtering wastefully immature animals.

Milk production is a rather different process, and there is probably less wasteful feeding in dairy herds, but there is undoubtedly a fair amount of it, and possibly a good many cows are let off their milk unnecessarily each autumn because sufficient provision has not been made in the way of having kale or other succulent roughage ready to feed.

On dry land, feeding kale where grown might be a considerable economy of labour in harvest time. It was very much recommended by Professor Wibberley who wrote some twenty years ago, but was not much adopted, on account of the fencing difficulty, I think. This can now be got over by the use of an electric fence, which is quite effective and can be very easily moved to give the daily ration.

I might also refer to waste of land. Although a great many farms are most carefully worked, and not a foot wasted at fence sides, there is a serious amount wasted here and there. Perhaps more in England than in Scotland there are great areas shaded and spoilt by overgrown hedges, and many unnecessary hedges which should be grubbed out. During the last three years on one farm under my control some 60 acres have been added to the ploughed area by grubbing out hedges, reclaiming corners and waste pieces which had been left for game covert, or through neglect, and the effect has been to ease the working of the farm enormously, and reduce the damage by vermin to vanishing point.

Another form of waste of land is under-farming, and growing inferior crops and grass. If every farm in the Kingdom was tuned up to the level of the best-farmed of its particular type, the increase in production would be enormous. In ordinary times many farmers deliberately under-manure corn crops on account of the possible difficulty of harvesting, but under present conditions this is unjustifiable, and, in any case, it does not apply to grass and root crops.

The careful harvesting and protection of crops of all kinds will eliminate much waste, but in many cases it is most difficult to lay down rules for its prevention. Cutting corn too early may cause very considerable loss, and many instances of this occurred last harvest, but most of it was, I expect, the result of an attempt to keep the work in hand in the face of a labour shortage. The loss by cutting too late is frequently serious, especially with some of the newer varieties of oats, such as Early Miller, which, while standing well up to a point, suffer from a complete collapse of the straw when over-ripe, resulting in frightful waste of grain through cutting of the tangled straw. The newer Danish varieties

of barley lose grain very seriously by shedding when fully ripe, and the reel of the binder will strike off a large quantity when run fairly fast, as is the case with most power drive binders. It is difficult to alter the speed, but the arms of the reel can be shortened somewhat, and this gives a slower motion to the circumference.

Careful stooking, with the stooks all set with their ends slightly west of south, so that the east side gets rather a longer turn of the sun, is very beneficial, and helps uniform drying. It is rather harder to do than one would imagine, but is well worth the trouble.

Stacking varies very much in different districts, but is usually well done in Scotland. In the north-east, where small stacks are the rule, they are usually built so that the sheaves hang outward, with as much angle as to make them almost independent of thatch, but, where larger stacks are built, either round or rectangular, this is more difficult, and early and efficient thatching is generally of vital importance and may save much waste.

Harvesting of potatoes is usually a fairly wasteful business, especially in a late season when the earth is wet. There is no doubt that the old spinner digger damaged a great many by striking with too much force. Many attempts have been made to prevent this, but usually where they damage fewer they bury more. The machine which makes the best all-round job is one with a slow-working vertical wheel forking the potatoes on to a horizontal wheel. This machine leaves most of the potatoes either on the surface undamaged, or so slightly covered that one stroke of a harrow uncovers them. The new American power-drive machine is most efficient in leaving all potatoes on the surface in a row easy to gather, and is very economical of labour, but, unless fitted with a variable speed gear, it bruises and chips rather too many. A good deal of waste takes place every year through insufficient thatching of pits. It is essential that plenty of straight straw be used as a protection against frost; unless the straw is straight the water goes right through, and terrible loss and waste may result.

To store or not to store turnips has been a matter of controversy as long as I can remember, and, until the past two winters caused me to revise my opinion somewhat, I had decided that storing a fortnight's supply was sufficient. The loss and waste through leaving them in the field was compensated for by the saving of labour and the superior palatability of turnips and swedes fresh from the field; also in many winters the tops supply an important item of fodder. Using direct from the field is much more economical of labour, as it saves a handling and also saves the cleaning of turnips from the store, which is necessary, especially in an open mild winter when stored roots grow more and become covered with white growths. It is difficult to suggest

any hard and fast rule, but, in view of the fact that it will be difficult to replace turnips by other feeds in the coming winter, it will be prudent to store rather more than usual if labour will permit.

Waste of pasture grass is very noticeable in some districts, especially on the less fertile soils, and usually indicates lack of lime and under-manuring. In theory, nothing is more easy, and, in practice, nothing more difficult than to manage pastures well, and to have them always in the best condition for the stock, and yet never to be short of feed. The waste in old pastures grazed by sheep is in many places excessive, but the subject is so large, and so much has been written on it lately, that I need say no more than that the plough, lime and manure are the most likely cures. Cutting over the rough is of enormous value in the management of pastures, but will not compensate for bad soil conditions.

Perhaps I may finish by quoting Shakespeare: "It is a good divine that follows his own instructions," and saying that I have no special claim to sanctity.

SCOTTISH DAIRYING IN WAR-TIME.

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It is hardly necessary to emphasise the importance of maintaining an adequate supply of milk and milk products in time of war. From the nutritional aspect an ample intake of milk is, for certain classes of the population (*e.g.* infants, children of school age, and invalids), essential, while for the adult population the increasingly high proportion of cereals in the diet enhances the value of milk, and particularly of cheese, as sources of animal protein and animal fat. From the agricultural aspect the production of milk is, too, particularly well adapted to war-time conditions: of all our livestock the dairy cow is by far the most efficient converter of animal feeding-stuffs into animal products, and this fact, coupled with her ability to derive the larger part of her ration either from grass or, in winter, from home-produced fodders, places the milking animal in a class apart at a time when the supplies of imported feeding cereals and concentrates are scarce.

It is obvious, however, that if these supplies are still further curtailed (as indeed seems inevitable), and if, at the same time, the difficulties associated with the shortage of farm labour increase, there will tend to be both a reduction in the volume and a deterioration in the quality of the milk supply. In this connection it must

be emphasised that agriculture differs fundamentally from most other industries in that the time taken to effect any substantial improvement in production is relatively long: the farmer has to make his plans nine, twelve, or even eighteen months ahead. This is particularly true of dairying, where any alteration in the time-table of calving dates not merely fails to affect milk production until after the lapse of some nine to twelve months, but fundamentally influences the whole composition of the herd over a period running into years. In considering future policy regarding the milk supply it is therefore specially important to be able to forecast both the probable demand for milk and milk products and the factors which might adversely affect the volume of their production. The object of the present article is to review these two general aspects of the country's milk supply in so far as they concern the Scottish dairying industry. In addition, brief reference will be made to the complementary subject of the maintenance of the *quality* as distinct from the *quantity* of the milk supply.

Pre-War Production and Allocation of Supplies.—In attempting to forecast the potential war-time production of milk and milk products it is necessary to discuss in some detail the country's pre-war output of milk and the allocation of this output between the liquid and manufacturing markets. Published figures are available regarding the milk handled by the three Scottish Milk Marketing Boards during the year immediately preceding the outbreak of war, *i.e.* 1938. These figures do not, however, include milk retained for consumption on farms, nor do they include milk and milk products produced on the farms of non-registered producers. The most recent information which is available regarding these two categories is that collected by the Department of Agriculture for Scotland in 1935 and published in *Agricultural Statistics,* 1936. Although the development of the Marketing Boards' activities during the intervening years will to some extent affect the validity of these latter figures, they are probably accurate enough to be used as a rough basis of calculation.[1] Using the two sets of figures, the estimated output of milk and milk products for the whole of Scotland for the years 1935-38 has been computed. The figures for the complete year (in millions of gallons) are given in Table 1, while the monthly output of milk and milk products is illustrated diagrammatically in Fig. 1. It will be noted that the quantities "retained on farms" and "sold off farms" (viz., available to the general public) have been differentiated.

[1] In support of this statement it may be noted that the Department's figures for 1935, which were obtained directly from producers, agree closely with the independent returns published for the same year by the Milk Marketing Boards.

TABLE I.

Yearly Utilisation of Milk in Scotland (1935-38) (in millions of gallons).

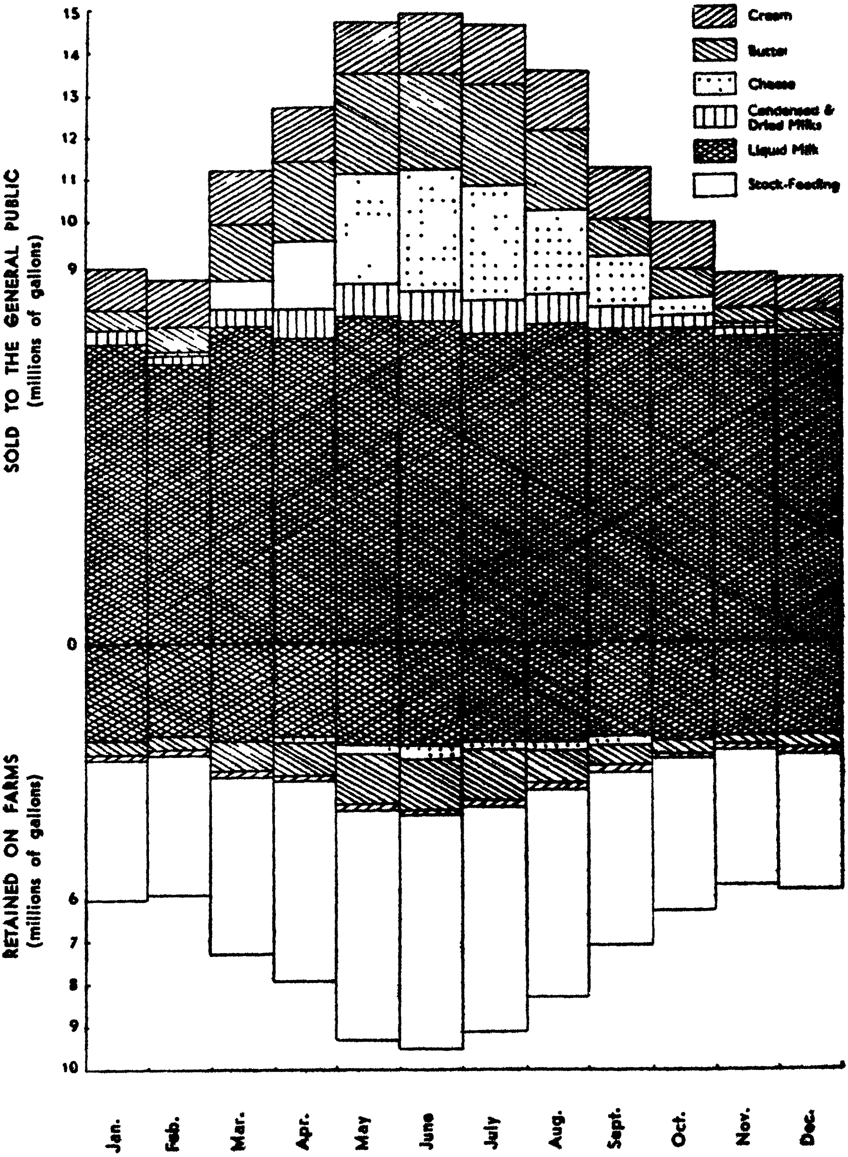
	Retained on farms.	Available to public.	Total.
Liquid milk - -	27·3	87·7	115·0
Condensed and dried milks - - -	—	5·7	5·7
Cheese - - -	1·2	14·3*	15·5
Butter - -	7·8	15·8*	23·6
Cream - - -	1·2	14·0*	15·2
Fed to stock - -	50·7	—	50·7
Total - -	88·2	137·5	225·7

* These figures include both factory-produced products and products produced on, *but sold off,* farms. The quantities of milk utilised for the latter products are 5,025,000, 4,590,000 and 1,220,000 gallons for cheese, butter and cream respectively.

Special attention may be directed to the following outstanding features. *First,* it will be seen from the upper portion of Fig. 1 that the production of milk is essentially seasonal, being at a maximum (14 to 15 million gallons per month) in midsummer, when the combined effects of the high rate of spring calving and of the abundant supply of nutrients from grazing are operative, and at a minimum (8 to 9 million gallons per month) in midwinter, when the milking stock (whose numbers are already reduced as a result of the lower rate of autumn calving) are dependent for their sustenance on indoor feeding. The consumption of liquid milk is, on the other hand, remarkably level throughout the year, averaging at roughly 7½ million gallons per month. The net result of these two opposing trends is that the manufacture of milk products is more or less confined to the summer months. In round figures roughly four times as much milk is manufactured in the seven summer as in the five winter months. *Second,* it will be noted that the combined figures for butter and cream claim by far the largest share of the milk used for manufacture, accounting for roughly three-fifths of the total. While, however, the production of butter is largely seasonal, cream production absorbs a fairly constant quantity of milk throughout the year. The manufacture of cheese, utilising one-third of the manufacturing milk, shows the greatest seasonal peak, being virtually confined to a six-months summer period. The production of condensed milk and milk powder is more evenly distributed, but represents only a small proportion (roughly 10 per cent.) of the total milk used for manufacture. *Third,* a comparison of the

upper and lower portions of Fig. 1 shows strikingly the relatively large proportion of the country's milk supply which is retained on farms. About one-third of this is used for home consumption or as perquisites or sales to employees and close neighbours. The remaining two-thirds are used for stock-feeding. Further reference to this aspect of the subject will be made later. The

FIG. I. MONTHLY UTILISATION OF MILK IN SCOTLAND, 1935-38.



important fact to stress at this point is the remarkably large reservoir of milk which is retained on farms for one purpose or another, amounting in all to nearly 90 million gallons out of the country's total output of roughly 225 million gallons, *i.e.* to some 40 per cent.

War-time Allocation of Supplies.—It is obvious that the nation's war-time requirements for milk and milk products will differ from those of peace-time. It will be convenient to deal separately with liquid and with manufacturing milk.

Liquid milk.—Pre-war sales of milk to the general public totalled just under 90 million gallons per year. If this were to be distributed evenly throughout the general population (*i.e.* excluding those resident on farms), it would allow of a daily consumption of just under half a pint per head. As regards the farming population, the average consumpt would be markedly higher, owing to the relatively large quantities of liquid milk retained by the producer for home consumption. The actual figure works out at three-quarters of a pint per head per day. These figures coincide closely with those obtained in an extensive survey carried out some ten years ago under the auspices of the Department of Health for Scotland (1).

The farm consumpt would be generally recognised as fully adequate to ensure good health, particularly as rural populations have ready access to alternative "protective" foods, such as green vegetables and fruits. The general consumpt is, on the other hand, definitely on the low side. Since the outbreak of war certain developments have, however, already tended to correct this deficiency. Of these the most notable are the general increase in the purchasing power of the industrial population, the use of milk in place of other animal products (*e.g.* meat and eggs) which have become scarcer, and—probably most important—the inauguration of the National Milk Scheme, which enables milk to be supplied to young children and expectant and nursing mothers either free or at specially reduced rates. The provision on a voluntary basis of two-thirds instead of one-third of a pint under the milk-in-schools scheme has also tended to increase consumption. It is difficult to forecast the effect of these developments on the general *per capita* consumption, though it is pertinent to note that a substantial expansion in the sales of liquid milk has already been recorded by the Scottish Milk Marketing Board (2). It is probable that an all-round increase in demand of at least 15 per cent. must be expected, which would raise the total liquid requirement from just under 90 to just over 100 million gallons per year, or an average of 8½ million gallons per month.

Allocation for Manufacture.—Two factors need to be taken

into account in forecasting the allocation of milk for manufacture, namely, the relative nutritional value of the various milk products and the import policy of the Government. As regards the former, the chief consideration is the loss of nutrients during manufacture. From this point of view condensed and dried milks should receive first priority, since these products retain the whole of the nutrients of the original milk practically unimpaired. Moreover, the threatened shortage of liquid milk during the winter months justifies their production and storage on a considerable scale. Next in order of priority would come cheese, in the manufacture of which the only substantial loss is that of the milk sugar, which is largely run off with the whey. Facilities are, however, now available for conserving this potential waste in the form of dried whey. Last on the list would be butter and cream, which contain little except the milk fat. It is, of course, true that the separated milk from butter and cream production can be dried, but the resulting powder is at present largely diverted to animal feeding and is thus lost to human consumption.

In practice the manufacture of cream, which is essentially a luxury product, has already been banned by legislation. As regards butter, it is understood that priority of importation has been given to essential fats (either butter fat or its substitutes), so that it should be unnecessary to allocate any substantial quantities of milk to butter-making. As between condensed and dried milks and cheese, two additional factors must be taken into account. One is the effect of dietary habit on demand: the value of cheese as a palatable and attractive substitute for meat, and its wide use in the diet of certain sections of the industrial population, justify its production on a substantial scale. The other is the question of plant capacity, which will obviously be a limiting factor in the final allocation of supplies Taking into account these various considerations, the following tentative estimates of production may be made :—

Cheese—Cheese is made both on a factory scale and on individual cheese-making farms Before the formation of the Milk Marketing Boards, farm-house cheese-making predominated, and in 1925 over 16 million gallons of milk were used for this purpose. By 1935 this figure had been reduced to 9 million gallons, and by 1938 only a little over 6 million gallons were utilised by farm cheese-makers. It is obviously desirable to obtain a maximum output of farm-house cheese at a time when transport difficulties are likely to increase. On the other hand it must be recognised that a number of difficulties are likely to be encountered in any attempt to expand production under war conditions. The shortage of skilled labour will inevitably prove a serious

problem. Again, much of the cheese-making equipment will probably have been disposed of or will be in a state of disrepair. And again, where the ploughing-up campaign has encroached on grazing land, farm cheese-makers, who are essentially seasonal milk producers, will be particularly hardly hit. Under these circumstances it is doubtful whether farm cheese-making could absorb more than the immediate pre-war figure of 6 million gallons.

As regards factory cheese-making, this is now largely under the direct control of the Scottish Milk Marketing Board, which has acquired and re-equipped most of the cheese-making creameries in the south-west of Scotland. In 1938 just over 9 million gallons of milk were used for the production of factory cheese. The extent of possible expansion in the output of such cheese is strictly limited, since (unlike condensing and drying) cheese-making is a "batch" operation. By working to full capacity for a five-months summer period it should, however, be possible to increase the throughput of milk to, say, 12 million gallons. This would bring the total milk allocated to cheese-making up to 18 million gallons.

Under the present cheese-rationing scheme the weekly allowance per head of the population is 1 oz., with a special ration of 8 oz. for miners and agricultural workers. It is interesting to note that, if this were to be met entirely by home production, it would require an annual output of 200,000 cwt. of cheese equivalent to about 23 million gallons of milk.

Condensed milk and milk powder.—The manufacture of condensed milk and milk powder in Scotland is a relatively new venture: it may be said to have been built up entirely within the past ten years. Yet the quantity of milk absorbed by this branch of the industry is already considerable, the pre-war figure for the production of condensed milk being nearly six million gallons. The amount of *whole* milk used for drying has been small (under 200,000 gallons), but there has been a very substantial output of dried *separated* milk, so that considerable facilities for drying are in fact available.

Both condensing and drying are "continuous" operations, and by working to full capacity a large increase in production should be possible. Moreover, the erection of new condensing plant (2) has very considerably increased the quantity of milk which can be handled. Taking into account these two facts it is probably not unreasonable to expect a doubling of the output of condensed milk, which would thus require an annual throughput of 12 million gallons. As regards drying, it is likely that most of the roller-process plants will be required for the production of dried whey. The spray-process plants which have recently been erected in Scotland could, however, be usefully employed in producing high-

grade whole milk powder. The only objection to the conservation of milk in this form is its tendency to develop a form of fat deterioration ("tallowiness") during prolonged storage. The technical difficulties involved are, however, being energetically tackled, and a solution to this problem is not likely to be long delayed. At a rough estimate, the existing spray-process plants could absorb some 15,000 to 20,000 gallons of milk per day. Taking the lower figure, and limiting production to the summer months, this would call for an annual allocation of about 2 million gallons.

Butter.—It has already been noted that under war conditions milk should not be allocated in any substantial quantities for butter-making. There are, however, two sources of home-produced butter which would inevitably absorb a certain quantity of milk. In the first place, it is frequently necessary to utilise for butter-making milk returned from retail sales. The quantity of milk involved is relatively small, and might be roughly estimated at 1 million gallons. In the second place, butter is made on the farms of a considerable number of both registered and non-registered producers, the total amount of milk involved reaching the very high figure of over 12 million gallons. About two-thirds of this is retained for consumption in farm households, the proportion so retained being particularly high in the northern area of Scotland. In the north-eastern and south-western areas, however, the amounts sold to the public are considerable. Although the increasingly attractive price offered for liquid milk will probably divert a portion of this milk to the liquid market, a fair quantity of milk, which may be roughly estimated at 2 million gallons, will continue to be manufactured into butter and sold to the public. The total annual allocation of milk for butter-making may therefore be assessed at 3 million gallons.

Balancing Requirements and Supplies.—It is now possible to arrive at a rough total of the milk needed to meet both the liquid and manufacturing requirements. For convenience the figures have been summarised in Table 2.

TABLE 2.

*War-time Allocation of Scottish Milk Supplies**

(expressed in gallons of liquid milk).

Liquid consumption	102,000,000
Cheese	18,000,000
Condensed milk and milk powder	14,000,000
Butter	3,000,000
	137,000,000

* Excludes milk and milk products retained on farms.

It will be seen from this table that the overall requirements amount to 137 million gallons. Comparison with Table 1 shows that this corresponds almost exactly with the overall pre-war production. Provided, therefore, that production could be maintained during the war at the pre-war level, the savings made by banning the sale of cream and by discontinuing large-scale butter production would be just sufficient to offset the increases in the sales of liquid milk and in the manufacture of cheese and of condensed and dried milks.

There are, however, clear indications that this objective is very unlikely to be achieved. The shortage of winter feeding-stuffs has already caused embarrassment to many producers. The ploughing-up campaign, while ultimately beneficial to the productivity of grassland, will probably result in a temporary shortage of grazing on many dairy farms. Labour difficulties are also likely to affect the output of milk, while other incidental factors, such as protracted outbreaks of foot-and-mouth disease and adverse climatic conditions, are of special consequence under war conditions. There is, too, the possibility of a substantial loss of milking cows by sale to England, so that, although sales of milk across the Border have been discontinued, the export of potential milk-producing stock may result in an equivalent loss of milk to Scotland.

By the end of the European War of 1914-18 there was an overall reduction in the milk supply of Great Britain of 25 per cent. While it is impossible to forecast with accuracy the probable supply position during the present war, it is probably not unreasonable to allow for a 10 per cent. reduction in the summer output of milk, and at least a 20 per cent. reduction in the winter output. This is, in the author's view, a very conservative estimate, but even so it would be sufficient to reduce Scotland's available output of milk to less than 117 million gallons, thus causing a gap of over 20 million gallons between the requirement and the supply. How could this gap be closed?

Closing the Gap.—It is clear that no one method can be expected to bridge a gap of this magnitude. The following suggestions, each of which, if adopted, would exert a beneficial effect on the supply position, appear to warrant special consideration.

(1) Since the major factor in reducing the output of milk under war conditions is undoubtedly the shortage of feeding-stuffs (3), this subject must take precedence over all others. The country's feeding-stuffs position has been extensively surveyed in a series of articles by the present author (4, 5, 6), and any further detailed discussion of the problems involved would be

out of place here. Two points cannot, however, be too strongly emphasised. *First,* the fundamental difficulty, so far as the cattle population is concerned, is the shortage of *winter* feeding-stuffs. This fact is well illustrated in Table 3, where an attempt has been made to compare the total nutritional requirements of Scottish livestock (excluding pigs and poultry) with the nutrients available from home-grown feeding-stuffs. In calculating the latter, the summer figures refer only to the nutrients derived from grazing, including grazing on rotation and permanent pastures, on aftermath and on rough grazings. The winter figures include the nutrients derived from cereals, roots, green crops, hay and straw.

TABLE 3.

Comparison of Supplies of Home-Grown Feeding-Stuffs with Requirements of Scottish Livestock, 1938*

(thousands of tons).

	Full Year.		Winter Season.		Summer Season.	
	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.
Requirements -	622	4,302	303	2,110	319	2,192
Available supplies	560	3,512	155	1,270	405	2,242
Surplus (+) or deficit (−) -	−62	−790	−148	−840	+86	+50
Percentage surplus (+) or deficit (−) -	−10	−18	−49	−40	+27	+2

* These figures exclude the requirements of pigs and poultry, which are fed almost exclusively on cereals and concentrates, most of which are imported from overseas.

The table shows clearly that, while the requirements of stock are fully met (in the case of protein they are substantially exceeded) from grazing during the summer, there is a shortage of between 40 per cent. and 50 per cent. in the nutrients available for winter feeding. In actual practice the surplus of grass nutrients would be considerably higher, since part of the home-produced cereals are invariably fed during the summer season, not only to balance the protein-rich grass but also to provide a high energy feeding-stuff for working animals. *Second,* in looking for a suitable substitute for the purchased feeding-stuffs which have hitherto been the basis of winter rationing, special attention should be directed to high-quality grass silage, which provides the necessary nutrients in a correctly balanced and palatable form and which could be obtained from the surplus summer grass (7). It is, however, clear from Table 3 that, in order to secure the requisite quantity of herbage for ensiling, it would be necessary to raise substantially the grassland yields, a step which could be readily achieved by the application of quick-acting nitrogenous manures.

(2) It has already been pointed out that, as shown in Fig. 1, an extremely large volume of milk is retained on farms, either for stock-feeding or for home consumption. Of this, some 50 million gallons of milk are fed to stock. The practice of providing calves with an ample supply of milk is clearly justifiable in peace-time, but in circumstances in which the diversion of every possible gallon of milk to human consumption is of vital importance, the amount fed to calves should clearly be reduced to the minimum consistent with the maintenance of condition and stamina. Moreover, during recent years valuable knowledge has been accumulated regarding the use of milk substitutes for calf-feeding, and it has even been found possible to rear calves successfully without any whole milk whatever, provided that dried separated milk or some similar substitute is available (8). It may, incidentally, be noted that the feeding of Scotland's total calf population at the average rate of 1¼ gallons per day for, say, 3 months would only require 32 million gallons, as against the 50 million gallons actually used. It therefore appears that, within limits, part of the milk at present used for stock-feeding might be looked upon as a valuable potential reservoir of milk for human consumption.

As regards the milk consumed in farm households, it has already been made clear that residents in rural areas at present benefit in comparison with the urban population. This applies with equal force to the butter retained for consumption on farms, in the production of which nearly 8 million gallons of milk are used. It would, however, be extremely difficult to raid these supplies except by providing a very substantial price incentive. Moreover, as regards butter, the largest proportion retained on farms is that produced in the northern areas of Scotland, where presumably the lack of convenient markets prevents its sale to the general public.

(3) Even in peace-time the drain on the country's milk supply through various forms of cattle disease represents a serious monetary loss: in war-time the loss of the milk itself is an even more serious matter. It is not easy to arrive at an accurate estimate of the extent of this loss, but approximate figures can be obtained from data published in a recent report of the Survey Committee of the National Veterinary Medical Association (9). Using the Committee's basis of computation, the loss to the Scottish milk supply from bovine mastitis works out at some 6 million gallons per year, from contagious bovine abortion at more than 3½ million gallons, and from sterility and temporary infertility (usually attributable to infection with contagious abortion) at over 11 million gallons.

The prevention of these losses, or even their substantial reduction, would go far towards meeting at least part of the

anticipated milk shortage. As regards mastitis, strict attention to hygienic precautions and to improved methods of management definitely mitigate the effects of the disease, while there is increasing evidence that drug therapy is capable in many cases of clearing up infection. As regards contagious abortion and the related conditions of temporary and permanent sterility, marked improvement can usually be secured by vaccination with an appropriate vaccine (10). An extension of these measures against mastitis and abortion on a nation-wide scale would undoubtedly have most marked beneficial results on the volume (and incidentally the quality) of the milk supply.

(4) The three general measures so far discussed refer to possible means of increasing the supply of milk available for human consumption. It appears inevitable, however, that in order to ensure an equitable distribution of milk to the various classes of the community some form of milk rationing will ultimately have to be instituted. This would enable relatively rapid adjustments to be made in demand in order to meet sudden alterations in the supply position. The necessity for some such measure is best illustrated by reference to the winter milk supply. If the estimate of a 20 per cent. reduction in the supply of winter milk is accepted (and it has already been stated that there are indications that this is a very conservative forecast), the amount of milk available each month between November to February would be less than 7 million gallons. Consumption at the level mentioned earlier in this article would require roughly $8\frac{1}{2}$ million gallons, so that for at least four months of the year the available supply would be entirely inadequate even to meet the liquid demand. Clearly this shortage should be equitably spread over the whole community, rather than be borne by a limited section of the population or by residents in localities in which the supply position happens to be particularly difficult.

Milk rationing presents, however, certain special difficulties. For example, most households require a more or less constant daily supply of milk, and rationing on a weekly basis would therefore probably prove unsatisfactory. A weekly rationing basis would be even more inconvenient to dairymen, as well as to wholesale distributors, who would have no accurate guide as to the variations in daily demand. With a perishable commodity such as milk this would inevitably lead to serious wastage. An even more difficult problem is presented by the fact that the unit of sale is governed by the existing size of milk bottles, which are based on $\frac{1}{2}$-pint, pint and quart measures. The sub-division of the ration into units other than these (with the possible exception of the $\frac{1}{4}$-pint measure) would not be feasible. In theory, for instance, a daily allowance of 1 pint for infants and hospital patients, $\frac{3}{8}$-pint for children of school age and $\frac{1}{3}$-pint for adults,

would provide an equitable distribution, which would roughly meet the nutritional needs of each age group. But such a basis of rationing would clearly be quite impracticable. On the other hand, with a basic allowance of, say, ½-pint per head for the whole population, the allocation to the adult population (which would alone amount to about 65 million gallons) would leave an inadequate balance available for the various priority classes.

In these circumstances it appears that a system of basic allowances for each separate class of the population would require to be devised. Taking into account the relative nutritional needs of the various age groups, such a system of basic allowances might be as follows :—for children under 5, 1 pint; for children of school age (5 to 15), ½-pint; and for the remaining adult population, ¼-pint. Expectant mothers and hospital patients could then receive supplementary allowances of ¾-pint, children of school age would be entitled to an extra ⅓-pint under the milk-in-schools scheme (for which bottles are available), while non-institutional patients and others under medical treatment (say 10 per cent. of the population) could be given a special allowance of, say, ½-pint. Such a method of rationing would be reasonably flexible. It would leave the existing priority classes unaffected, would permit the continuation of the milk-in-schools scheme, and would allow special requirements to be met on medical grounds. In the event of any exceptional shortage of milk, the various allowances could be temporarily cut without serious detriment to the health of the community. Moreover, the total requirements of the population based on these rationing standards would amount (for Scotland) to only 90 million gallons, or an average of 7½ million gallons per month. This coincides reasonably closely with the estimated available winter supplies. It is true that the total annual consumption would thus revert to the pre-war figure. On the other hand the increased quantity of milk thus released for manufacture, *i.e.* 10 million gallons, would ensure that maximum quantities of condensed and dried milks (as well as of cheese) would be available for consumption during any periods of milk shortage.

The Quality of the Milk Supply.— So far discussion has been confined to the quantitative aspect of the milk supply. It is also important that the *quality* of the milk supply should be maintained at a high level. This subject falls naturally under two heads, *i.e.* the hygienic quality of the milk, and its chemical composition.

Hygienic quality.—The shortage of skilled farm labour, the difficulties of transport, and the lack of various facilities essential to clean milk production (*e.g.* fuel, equipment, etc.) would lead one to expect a serious falling off in the hygienic quality of the

raw milk supply. So far as routine laboratory tests are concerned, there seems as yet to be no indication of any such tendency in Scotland. For example, the results of nearly 70,000 methylene blue reduction tests taken at a number of creameries in the south-west show little variation from the pre-war values. In 1938, for instance, 85 per cent. of samples were classed as Grade 1 and just under 2 per cent. as Grade 4; in 1940 the figures were 82 per cent. for Grade 1 and 3 per cent. for Grade 4. The differences, small as they are, were entirely accounted for by the poor results obtained in one exceptionally warm month in 1940; in the remaining months the 1940 figures showed in general an improvement on the corresponding 1938 figures. Again, the sediment test classed 65 per cent. of samples as Grade 1 in 1938 against 73 per cent. in 1940, while 3 per cent. of samples were noted as very dirty in 1938, against only 1 per cent. in 1940.

More stringent bacteriological tests do not, however, entirely bear out these conclusions. Records of the ordinary plate counts of samples delivered to city depots do not, it is true, show any marked differences as a result of war-time conditions of production. There are, nevertheless, clear indications that the sterilisation of equipment and utensils is not now carried out so efficiently as before the war. This is most apparent from the results of laboratory post-pasteurisation counts, which provide an index of the contamination of the milk with heat-resistant bacteria: at one large distributing depot, for example, nearly a third of more than one hundred samples which were taken during a single week in March, 1941, gave post-pasteurisation counts of over 10,000 per ml. Good quality milk produced with the aid of properly sterilised equipment should give counts of well under 1,000 per ml. It may be noted that inspection of the farms concerned indicated that unsterilised milking-machines were largely to blame.

Difficulty in keeping the counts of pasteurised milk at a reasonably low level are, however, not solely associated with the conditions of production of the raw milk. Temporary disorganisation of transport is also liable to cause trouble, while the shortage of skilled workers at processing and distributing depots is already severe. Although the age of reservation has now been raised, this action has been taken too late to prevent the loss of essential workers. Moreover, serious problems have been encountered, particularly in heavily bombed areas, both by war-time restrictions and by local disorganisation of essential services. Thus the black-out conditions hinder the effective cleaning of the processing plant and equipment, while late deliveries of milk at the factory delay the commencement of processing and lead to the rushing of the

final operations. Air raids and air-raid damage may result in even more acute difficulties.

Where air raids are relatively intermittent such difficulties are only temporary in character, but, should air attacks intensify, milk distributors in densely populated areas would be faced with problems which would necessitate drastic alteration in the methods of processing and distribution. In such circumstances at least three steps would appear to be essential: first, the heat treatment of the milk at country depots (possibly by high-temperature short-time pasteurisation) followed by efficient chilling; second, the retention (and if necessary dispersion) of adequate bottling facilities throughout urban areas; and third, instructions to the general public to boil their milk as soon as possible after its delivery. This is desirable in case the washing and sterilising of the milk bottles has been ineffective, and would not only prolong the keeping quality of the milk, but would prevent any risk of the spread of milk-borne diseases. An additional safeguard is the provision of local emergency supplies of condensed milk or milk powder.

Chemical composition.—Two general criteria of quality are recognised for the chemical composition of milk sold to the public, *i.e.* a specified fat content and a specified content of solids-not-fat. The presumptive legal standard for butter fat content is 3·0 per cent., but the contract of the Scottish Milk Marketing Board stipulates that the fat content shall be not less than 3·5 per cent. for the months from August to January inclusive, and not less than 3·4 per cent. for the months from February to July inclusive. The solids-not-fat content is based on a presumptive standard of 8·5 per cent of solids-not-fat. Milk containing less than this proportion is presumed to be adulterated with water, unless the contrary can be proved by the vendor.

As regards fat content, there appears so far to have been little, if any, falling off in quality. Results of nearly 80,000 tests carried out at creameries in the first six months of 1938 showed that 98·6 per cent. attained the Milk Board's standard, against 98·4 in 1940. Results for the second six months gave 99·5 per cent. for both years. The proportion of samples falling below the legal standard of 3·0 per cent. fat was 0·03 per cent. and 0·01 per cent. in 1938, and 0·02 per cent. and 0·01 per cent. in 1940. Results obtained with samples delivered to city distributing depots have given very similar results.

As regards the solids-not-fat content, complaints have, however, been very widely made that adulteration is increasing. Probably the most delicate test for added water is the so-called "freezing-point" test, which is incidentally able to distinguish

definitely watered samples from samples of naturally low solids-not-fat content (*e.g.* samples from cows affected with mastitis). The following figures show the increase which has taken place in the number of samples containing added water at one distributing depot where some 700 samples are examined annually:—

1938 — 5
1939 — 9
1940 — 50
1941 — 31 (first three months only).

This increase in the extent of adulteration is confirmed by Public Health Laboratories; it was, in fact, a common experience during the last war, and appears to be associated with the higher price paid for milk combined with the general shortage in supplies. It is clearly a matter which merits immediate attention by the responsible authorities concerned.

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AGRICULTURAL LABOUR UNDER WAR CONDITIONS.

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A backward glance will enable us to keep the labour situation in perspective. When the last war broke out there were 3,295,487 acres of arable land in Scotland. That was gradually increased until it reached 3,453,495 acres in 1918. The Board of Agriculture for Scotland, as it then was, reported that in 1913 the number of male workers regularly employed on farms was

102,000, and the number of female workers regularly employed was 53,000. In 1921, when the next returns were made, the numbers were 82,099 males and 21,772 females. These figures, however, do not show the full effect of war conditions on agricultural labour. It was not only that the number of males was reduced by 20 per cent. and the number of females more than halved, but the quality of labour was seriously affected by recruiting for the army. The Board of Agriculture estimated that in July, 1918, 36·5 per cent. of the male farm workers were enlisted in the army, but the actual reduction in the number of males employed was 17·6 per cent. This means that the places of regular farm workers of adult age had been taken to the extent of 50 per cent by young lads under military age, and by substitute labour less experienced and efficient than the workers who had gone.

Let us look now at the trend of events since 1921. I have taken the figures from the Agricultural Returns for the mid-year of 1929, and for the year of the outbreak of the present war, 1939, and have set out these alongside the figures for 1921. These figures show the position in the first week of June in each year. I have prepared index numbers to show the trends during the period between the wars, taking 1921 as 100.

	1921	1929	1939
LABOUR.			
Males 21 and over	100	103	96
" under 21	100	92	80
Females	100	87	66
CROP ACREAGES.			
Corn	100	83	76
Root	100	91	80
Rotation Grass	100	102	98
Permanent Grass	100	112	118
NUMBERS OF STOCK.			
Horses	100	74	65
Cattle	100	108	118
Sheep	100	113	120
Pigs	100	98	178

The trends are pretty clear. The supply of adult male labour continued fairly steady up to 1935, and then began to show a fall; there was a steady decrease in the number of regular male workers under 21 years of age until about the year 1938; the number of females fell steadily throughout the whole period. It should be remembered that these figures include members of the occupier's family and relatives as well as wage earners.

The index figures for crops and stock show substantial

decreases in the acreages under corn and roots, with an increase in the numbers of the stock being carried on the farms. In face of these figures, and particularly of the reduction in the number of horses, it does not appear that the supply of labour before the outbreak of war, taken for the country as a whole, was out of line with the general trend in farming. There was nothing to indicate that the supply was short of the demand, and the trend of wages over the whole period would indicate that the supply was generally adequate. It was not until about 1935 that the shortage of younger men began to make itself felt in rising wages, and the demand for adults did not result in any general increase in wage rates for married men until about 1937, and then only in certain districts and to a very slight extent.

At the outbreak of war those farm workers who were reservists and territorials were called up. This did not mean a large number of agricultural workers, taking the country as a whole. The figures at 6th June, 1940, showed a reduction of men over 21 of about 700 as compared with 1939, but the figures for those under 21 were practically the same as for the previous year. The effect of the calling-up was mostly felt in the districts from Aberdeen to the north of Scotland, where the territorials had been more popular than in other districts. Since that time farmers have complained about the shortage of labour in different districts. There have been local shortages of regular workers from time to time, but, as a rule, the supply of regular workers has just met the demand. The shortage of casual workers has been more serious, and in some districts casual workers are not to be had.

Farmers were asked in the first year of the war to increase their crop area by 10 per cent. On most farms this could be done with the staff regularly employed, without any difficulty, because of the increase in the number of tractors and tractor implements on Scottish farms. In addition to this, the number of tractors available under the Government scheme, and the number of private contractors who were prepared to undertake tractor work on farms, provided enough mechanical power to overtake the increased programme. The remarkably favourable harvest weather in 1940 enabled the crop to be gathered from the increased acreage in record time, and there were fewer hours of overtime work on Scottish farms in 1940 than in normal years. The mechanical power has been increased this year, and should enable the regular labour force on the farms to make up to some extent for the shortage of casual labour. The position is very different from what it was during the last war. Then the voluntary enlistment of farm workers produced a shortage of labour which was general throughout the country at the end of the first year of war.

The shortage became more acute as time went on, and it was found necessary to release men from the army for farm work. It was a difficult problem in many districts to overtake the work with the substitute labour made available. So far, in this war, the position has been very different. Agriculture has had its workers reserved from very early ages, and postponements of calling-up notices for those under the reserved ages have been granted to many workers. Compared with the position during the last war the labour problem has not led to serious difficulty. If the need does arise for the farm workers in Scotland to stretch themselves to overtake a bigger programme than they have done so far, they will be able, with the mechanical equipment now available, to overtake what is required of them..

The war has made considerable changes in the wages of farm workers in Scotland. The Agricultural Wages Committees, which were set up under the Agricultural Wages (Regulation) (Scotland) Act, 1937, had completed their first fixing of minimum rates in the middle of 1938. If we take the ploughmen's rate as being the most typical rate for Scotland, we find that the minimum rates for adult ploughmen varied according to district from 34s. 6d. to 40s. a week, including the value of house and other benefits. The effect of fixing these rates was to raise the level of wages in the districts from Aberdeen to the north of Scotland, in the Borders and south-west of Scotland, and in the Highland counties, and to make a more uniform basis for wages everywhere. Although the Committees had no power to fix working hours, they had power to determine the week for which the minimum rate was payable, and in doing so they fixed a shorter working week in the south-west and in the north of Scotland, and in some other districts. By fixing overtime rates for work on Saturday afternoon they led to the introduction of the half-holiday where it had not previously been in operation. In most of the counties, however, the Committees' determinations did not affect the working hours.

These minimum rates were in operation when the war began. The increase in the cost of living during the first two months led to a proposal being made by the Scottish Farm Servants' Union that agreement should be come to with the National Farmers' Union and Chamber of Agriculture for Scotland, to which the Wages Committees might be asked to give effect, on the basis that no alteration should be made on the Wages Orders during the period of the war. except to give effect from time to time to such alterations in the rates of wages as would allow for the increase in the cost of living according to the official figures issued by the Ministry of Labour. The proposal was also made that for the period of the War these adjustments should be given effect to by the Wages Board, and the necessity for meetings of the Wages Committees

would not arise. Considerable time was spent in negotiations over this proposal, but, ultimately, the National Farmers' Union and Chamber of Agriculture for Scotland intimated that they were unable to agree. The Committees then undertook the revision of the minimum rates, and in March, 1940, new Orders were issued, the general effect of which was to increase the rates by about 10 per cent. The rates for adult ploughmen varied, according to district, from 39s. to 42s. a week, including the value of benefits. By the time these Orders came into operation the increase in the cost of living, according to the official figures, was 15 per cent. above the cost at 1st September, 1939.

Two months later the Government decided it was necessary to pass an Order to prevent employers from engaging any male worker whose normal employment is employment in agriculture, except for work in agriculture. The Minister of Labour and National Service indicated that, before such an Order could be passed to restrict the employment of agricultural workers to agriculture, it would be necessary to bring agricultural wages more into line with wages in other industries. In England the Agricultural Wages Act had been amended to give the Wages Board power to fix a national minimum rate, but in Scotland the amendment of the Act gave the Wages Board power to revise rates fixed by the Wages Committees, but not to fix a national minimum rate. The procedure adopted in Scotland to give effect to the Government's decision was for the members of the Wages Board to agree to recommend Wages Committees to fix 48s. as the minimum rate for a male worker of 20 years of age and over, and to increase the other rates accordingly. The Government were asked to exercise their special powers to enable the public notice of proposed rates and the consideration of objections lodged to be dispensed with, and the Committees were then able to submit their proposals to the Board with the minimum of delay. The result was that on 22nd July, 1940, the Wages Orders, as passed by the Wages Committees, were made operative by the Wages Board as an interim finding, the Board then proceeding to a complete revision of all the Orders. This revision was completed and new Orders became operative from 28th November, 1940. The minimum rate for any man of 20 years and over was fixed at 48s. a week for the whole of Scotland, and the minimum rate for any ploughman, stockman, or grieve, 20 years and over, varied from 52s. to 58s. a week.

Even if there had been no war, some revision of the minimum rates would have been made, and the granting of powers to the Wages Board to review the findings of the Wages Committees would probably have led to some levelling of conditions over the different areas in Scotland, but the fixing of what is in effect a

basic national minimum rate, with a corresponding levelling of the rates for specialist classes of workers, is a direct result of war-time measures. Fixed prices for farm produce were announced by the Government, and these prices took into account the increased wages to be given to farm workers. These facts, in addition to the restriction of employment of farm workers, paved the way for the removal of the wide differences which had existed between the minimum rates fixed in the different districts.

What has been said above applies to the minimum rates of wages, and the increases in the ploughmen's rates to 52s. from a level of 39s. to 42s. does not mean that all the farm workers in Scotland received increases of 10s. to 13s. a week. In several districts in Scotland the rates generally paid were in excess of the minimum rates before the Government intervened, and in all districts there were workers who were paid above the minimum rates. It was only in the Lothians, where the farmers have been more accustomed to collective action, that there was a general increase in the wages of adult workers to the same extent as the minimum rate was raised, which in these counties was 8s. 6d. a week in cash. In the other counties the general practice was to raise the actual wages to the new minimum rates. This meant that in the central counties of Scotland, say from Angus across to Ayrshire, the increases for married men ranged from 4s. to 6s. a week. Single men in bothies, or boarded and lodged by farmers, were mostly at or above the new minimum rates, and so their wages were not increased. I estimate that, instead of an average increase of 10s. 6d. a week as shown by the increases in the minimum rates for adult males, the actual increase averaged 6s. a week for the whole country, but the increases were very uneven in their incidence. Some farmers found themselves faced with an increase of 13s. a week, while others received the same increased prices as their neighbours and had not to pay any increase in wages.

The principal effect of the levelling of the minimum rates, as a war-time measure, was at first to effect a levelling at both ends, top and bottom. Very many workers who had been accustomed to hire much above the minimum rates found themselves, because of the long engagement, on the new minimum rates. It is relevant to point out that the increases which would have been necessary to meet the increased cost of living between 1st September, 1939, and 1st May, 1941, would have required increases for ploughmen of 10s. to 11s. 6d. a week, so that the higher-paid workers in Scotland have not benefited much from war-time measures. It is too early yet to arrive at a considered conclusion because the hirings, during the spring of 1941, indicate a tendency for the wages in the districts where rates have always been higher to move up from the minimum. If the demand for labour becomes

keener, as it will likely do, wages are likely to continue to rise above the minimum, but that depends upon the ability of the workers to move from one employer to another. So far the Undertakings (Restriction of Engagement) Order, 1940, has not limited the freedom of movement of workers within the industry, and indeed has not prevented a substantial trickle of workers away from the industry, but it will obviously be necessary to exercise more control over labour when the reserved ages are raised and agriculture is asked to provide its share of recruits for the armed forces. Any restriction of the freedom of movement of farm workers will require an extension of the power to regulate wages and conditions of employment beyond the fixing of minimum rates.

We may sum up the position then by saying that the supply of regular labour for farm work in Scotland has been adequate so far, but that there is a shortage of casual labour. It should be remembered that on the average in normal years only 10 per cent. of the wages bill on the farms goes to casual labour. It is only where there is a big acreage in potatoes and sugar beet that the casual labour problem assumes serious proportions. The regular labour supply is not likely to be seriously depleted, unless the demands of the armed forces are going to be increased beyond what has been announced so far. The annual recruitment of youths into agriculture exceeds the demands of the armed forces, and the relatively high wages paid to youths in the last few years are likely to counteract the tendency for the numbers to fall. It is more doubtful whether the number of the Women's Land Army employed on farms will make up for the number of regular women farm workers who leave the industry.

The effect of the war on the workers engaged in agriculture has been to speed up very quickly the movement to raise the level of wages of the lower paid workers, and to bring about in a few months a practically uniform set of minimum rates of wages throughout the whole country. It would probably have taken some years to work out any approach to uniformity in normal times. There are still substantial differences between conditions of employment in the different districts, and many anomalies which ought to be removed, but the workers have agreed to let these questions stand over until the end of the war. The levelling of the minimum rates has brought about a considerable increase in the rates of wages actually paid to the lower paid workers everywhere, but for the higher-paid workers all that has taken place has been to bring into force in the middle of the term the increases they would have had to wait another ten months to secure. In the last war the wages of the farm workers were generally about ten months behind the rising cost of living, but on this occasion they have got in ten months ahead.

CATTLE ON HILL GRAZINGS.

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BEFORE the time of the great Falkirk Tryst, Crieff, the centre of the district from which this article is written, used to be the greatest cattle market in Scotland. Cattle from all over the Highlands, largely reared on land now given over to deer forests or sheep grazings, used to be driven to the market there so that they could be sold to English buyers.

The depletion of our hill grazings of cattle and the oft-repeated story of the deterioration of these grazings have given me cause for thinking that they should again be stocked with cattle as well as with sheep. On every hand sheep farmers tell me that their grazings are no longer as good as they used to be. Fewer sheep are being carried, while the quality of the animals is not so good. They attribute this to various factors—spread of bracken, neglect of drainage and of heather burning, gradual impoverishment of the soil, spread of sheep diseases, deer, rabbits, etc. Fundamentally, some of the causes may be financial reasons. While admitting all this, I have come to the conclusion that the constant grazing of hill pastures by sheep alone is not a good thing for the pasture, and that the establishment of a permanent cattle stock on a hill grazing, in addition to the sheep, can be both highly beneficial to the quality of the grazing from a sheep farmer's point of view as well as profitable by itself on the cattle account.

Sheep and cattle have different grazing habits and do not, under hill conditions, compete with one another. The former graze the lower-growing and sweeter types of herbage, the latter the rougher types. When sheep are grazed alone on the hills, the rougher types of herbage are apt to crowd out the lower-growing sweeter types, and the rough grass so produced is wasted, being uneaten by sheep. Under such circumstances, too, the bracken plant tends to crowd out everything else. This means that in course of time some of the best and most fertile grazing areas of the hill are entirely lost to the sheep. If, however, cattle are put on to the grazing, the taller-growing herbage is grazed and the ground is eventually opened up for sheep, while the treading down of the bracken by cattle tends to reduce it. This means that, not only can a limited number of cattle be put on to a hill grazing without the numbers of sheep being reduced, but that the quality of the pasture is improved for the sheep. In short, from the sheep farmer's point of view, the quality of the grazing can be improved without its sheep-carrying capacity being impaired.

This brings me to my other assertion, viz., that the establish-

ment of a permanent cattle stock on a hill grazing can be a profitable venture.

In the first instance, the summer grazing costs little or nothing extra since no sheep need be displaced; secondly, the cattle can be wintered cheaply on hay, straw, etc., and without the need of permanent buildings; thirdly, the overhead charges for labour are low since what little labour is required can be done by the shepherds. The outlays are thus small, while the income, provided most of the cows produce and rear calves, may be considerably in excess of the outlay. But my chief reason for the above assertions is that I have tried my theory in practice, and have found that a permanent cattle stock may be established on a hill grazing, and will not only improve the quality of the grazing, but, on the cattle account alone, will return a considerable profit. There are, however, certain provisos :—

The stock must be established with as much care and thought as would a sheep stock, and must be on a permanent self-supporting basis so far as the maintenance of numbers is concerned. Cattle must be acclimatised to a hill in the same way, if to a lesser degree, as sheep.

In this connection the question of breed is important. In Scotland we are fortunate in having two hardy breeds of cattle, the Galloway and the Highland. Both will live outside, summer and winter, and thrive on the type of herbage found on the hills. Under my own conditions, I wished to have a type of animal that would mature more quickly than pure Galloways or Highlanders, and yet retain the hardiness of those breeds. The Shorthorn-Highland or Shorthorn-Galloway cow, if reared and kept under proper conditions, seems to me to be the most suitable type for the hills in Central Scotland. In establishing a herd, I would go upon these lines :—

Let us consider a hill grazing in the Highlands of Scotland, carrying a ewe stock of 1,000. Assuming that such a hill has one or two sheltered glens with, perhaps, a bit of bog in these, a herd of 100 head should be aimed at, made up as follows :—

20 Pure Highland Cows.
65 Cross Shorthorn-Highland Cows.
7-8 Cross Shorthorn-Highland 2-year-old Heifers.
7-8 Cross Shorthorn-Highland 1-year-old Heifers.

At the outset, the foundation stock of 20 Highland and 65 Cross Highland Heifers will have to be purchased. Care should be taken to see that these come from a good place where the cattle are reared under natural conditions. Heifers which have been well wintered on low ground and look "pretty" are not likely to do so well as those which have come straight from a

high grazing. They must, however, be deep-bodied and carry healthy skins. Two Shorthorn Bulls, 2 years old or over, will also have to be purchased, and these can be red, roan or white, according to the breeder's fancy. Some prefer a white as they consider that roan calves are more attractive, but, if the bull is a good type, colour is of no account.

The herd can be divided between the bulls or run as a whole, the bulls being put with the cows during the first half of June. As very young calves are never very profitable, the bulls should be taken out in early August, and run together in a paddock.

If it is desired to produce black calves from the Cross Highland heifers, then two Aberdeen-Angus bulls will have to be purchased to be mated with them. A Shorthorn bull will, of course, still have to be put to the pure Highland cows in order to produce the stock heifers to maintain the main part of the herd. The Cross Highland heifer, when mated with an Aberdeen-Angus bull, produces a very useful type of calf which, whilst not growing to perhaps the same size as would a calf by a Shorthorn bull, has the advantage of requiring no dehorning.

According to the date of service, calves will start to appear about the middle of March. The cows should be moved a week or two before calving to in-bye fields where they can be easily watched and assisted, if necessary, at calving. When the calves are about three or four weeks old the cows can be moved out to the hill or to outer paddocks. At the end of April or in early May, castrating and dehorning will have to be undertaken. Dehorning can be satisfactorily done with a sharp knife and a caustic stick to rub on the scar. Every calf should be dehorned, except the heifers from the pure Highland cows. Dehorned cattle are inclined to pack at night during cold weather and thus lose a measure of their hardiness, whereas cattle carrying horns never do so. For this reason the heifers from the Highland cows, which will be retained to maintain the cross Highland herd, should be left as nature intended them to be.

After this work has been carried through, the herd should be moved out to the hill, and will need little attention except a daily glance over by a shepherd.

The heifer calves which are being retained should be wintered in a sheltered field and given plenty of good hay—nothing else, The other calves may either be sold off their dams or in-wintered and kept going for sale in the spring. The cows can be brought through the winter on first-class straw with a little hay just before calving, and, according to seasonal conditions, for a week or so after calving. Fifteen tons of straw and three to four tons of hay will usually be sufficient, but on high-lying farms under severe conditions, such as were experienced last winter and spring, it

might be necessary to give as much as 25 tons of straw and 10 tons of hay.

The main consideration in building up and maintaining a herd on the above lines must always be to see that the cattle become thoroughly acclimatised to hill conditions, and that at no time during their lives are they pampered in the slightest degree. If some of the original bought-in heifers are unable to withstand the rigours of hill life—sell them. If a beast goes sick during the winter months and has to be housed—sell it.

It will be found that once a cow reaches four years of age she retains her condition during the winter more easily than a younger beast. Some cows will breed on till 17 and 18 years of age, but, to safeguard against loss, they should be cast at about the age of 12. Heifers may be served at two years of age if on a good grazing, but, on the poorer types of land, it will be found better to let them grow on till three before putting to the bull.

Fencing.—Generally speaking, when cattle are grazing on the open hill they do little or no damage to fences or dykes, but, if these are in need of repair, then cattle will find a way through and widen any existing gaps. Bulls may sometimes push their way through gates and light rail fencing if they see other cattle on the other side. There is, however, one point which must not be overlooked. If a river forms a boundary on a sheep farm this, whilst keeping sheep back, will be an attraction to cattle. They will make for the water on warm sunny days and will wade through, even at a depth of four feet, if the river bed is smooth and gravelly. Any fence which is erected should not cut the cattle off from the river entirely, but should cross to the adjoining bank at certain places.

Winter Fodder.—On some farms a certain amount of hay will be made, and it should be a simple matter to increase the tonnage by suitable manuring or by reseeding worn-out pasture. It must also be borne in mind that, whilst sheep will refuse badly got hay, cattle will clean up everything. There need not, therefore, be any waste. If an oat crop is grown, the straw can be fed to the cows. It should not be necessary under these conditions to make ensilage, but this would undoubtedly help the cows enormously just before calving, and during any period in which they had to be fed after calving. Here again, the improvement of existing pastures should provide sufficient material.

Drainage and Hill Pasture.—These two points may be considered together as they have a distinct bearing one upon the other. Assuming that portions of a hill are in need of drainage, little immediate benefit can accrue to the sheep by carrying out this

work unless the rougher types of herbage are eaten down. Sheep will not open up such ground, but cattle will transform the roughest bog into green pasture, if they are put on at the same time as the draining is carried out. They will do no damage to the drains themselves, although they may knock or pull in clods if these are not thrown well back when the drain is cut. If, however, they do block a few drains with these turfs, it is a simple matter for the shepherd to clear them with a graip on his daily rounds. The benefit the cattle will do will outweigh a hundredfold the extra work entailed.

As already mentioned, cattle will also open up for the sheep many other parts of the hill where the finer grasses have been swamped by the rougher types. On account of this it can be said that, far from causing a diminution in the sheep stock, cattle will help to increase the number of sheep which a hill will carry. At the same time the existing stock will greatly benefit by the improvement in the general grazing on the hill.

This article has not touched upon the question of summer grazing of cattle on hill pasture. That is a subject by itself, and, although summer grazing will undoubtedly improve the quality of a hill grazing, it will not have the same beneficial effects as will the continual grazing all the year round by a permanent herd. There is usually abundant growth in summer, and cattle will not tear down the rough herbage then as they will during the winter months.

The foregoing observations are set down as a result of the experience gained in establishing a permanent herd on a hill grazing which I happen to have. My experiences have shown that having animals that will stand the conditions to which they are exposed is of vital importance. On a number of occasions I had to get rid of animals which, when bought, appeared to be very good, but which later would not stand up to the rigours of hill life. Once a herd becomes established the matter of maintaining hardiness should be comparatively simple.

In conclusion, I wish to point out that my opinions have been formed as a result of experiences gained in the Highlands of Central Scotland. They may not apply to all districts, but, in a general way, I am strongly of opinion that much greater use might be made of our deer forests, rough grazings, etc., were cattle to be more extensively grazed in them than at present.

THE EFFECTS OF MOSAIC DISEASES ON POTATOES.

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ALTHOUGH a considerable number of accounts have been published dealing with the effects of leaf roll and with the degeneracy of stocks caused by all grades of mosaic disease, it was thought desirable to obtain further information of a statistical character on the effects of the various types of mosaic disease as recognised in Scotland. A similar investigation on wilding types was carried out simultaneously.

The investigation was primarily intended to furnish a guide to the uniform grading of degenerative conditions for the purposes of official certification of stocks, but the figures obtained in the course of the investigation have been striking enough to justify their being recorded.

Mosaic Diseases.—The grades of mosaic disease are, 1, negligible mottle; 2, mild mosaic; 3, border-line severe mosaic; and 4, severe mosaic. These are now well known in Scotland, and the symptoms and causative viruses have already been described (1). Accordingly, in 1936, tubers from plants of Majestic affected with these diseases were saved from those plots which had been marked out as standards for teaching and demonstration purposes, and stored in boxes over winter. Healthy tubers were retained from the Stock Seed demonstration plots. In February healthy and diseased tubers were thoroughly mixed and set rose end up in sprouting boxes, evenly sized tubers being used throughout. Planting took place in April, the tubers being spaced at 18-inch intervals in 27-inch drills. A row of healthy plants was planted round the plot to obviate interference from paths, but these were discarded at lifting time. During the growing season the plots were carefully examined and each plant was classified as to health and staked, there being a different coloured stake to represent each grade of disease. Although the maturity of the plants varied with the state of health, those with severe mosaic ripening first and the healthy plants last, lifting was delayed until all haulms were dead. Each plant was lifted separately and weighed, the produce of each grade of disease being bulked, later to be dressed and weighed. Figures were also obtained for the variety Arran Chief. The experiments were repeated in 1938, but on a considerably larger scale.

In the following table Column 1 shows the state of health and the viruses responsible, the mild strains of virus X being represented by X^- and the severe strains by X^+. Column 2 shows the number

of plants comprising the plot, the top row in each case referring to the 1937 figures and the second to the 1938 figures. Columns 3, 5, 6, 7 and 8 give the weights over the various riddles. In column 4 the weight of ware for each disease is expressed as a percentage of healthy which is taken to be 100. Similar figures are given for the total weights per root in column 9. Columns 10 and 11 show the percentage loss in yield as caused by each disease.

TABLE I.

Majestic. Average weight per root in ounces.

1	2	3	4	5	6	7	8	9	10	11
									Percentage loss in	
State of Health.	*No of Plants	Over 2 in		1½ × 2 in.	1¼ × 1½ in.	Chats	Total.		Total Yield	2 in. ware
Healthy	98 125	46·9 46·3	100 100	10·6 7·0	3·7 2·0	0·8 0·9	62·0 57·0	100 100	nil nil	nil nil
Negligible Mottle X⁻ or A	25 258	35·4 38·9	75·5 84·0	13·7 7·6	3·8 2·2	0·9 0·8	53·8 49·4	86·8 86·7	13·2 13·3	24·5 16·0
Mild Mosaic X	40 166	28·4 26·6	60·6 57·2	14·1 8·3	4·6 2·0	1·1 0·4	48·2 37·3	77·7 65·5	22·3 34·5	39·4 42·8
Border-line Severe Mosaic A + X or X⁺	15 101	17·0 23·5	36·2 50·6	9·2 6·9	4·3 1·7	0·4 0·5	30·0 32·5	49·8 57·0	51·2 43·0	63·8 49·4
Severe Mosaic usually A + X⁺; Y, Y + A or Y + X occasionally	32 177	7·7 9·5	16·4 20·5	12·1 7·4	4·3 1·4	0·4 0·4	24·5 18·7	39·5 32·7	60·5 67·3	83·6 79·5

The table shows the actual yields and reductions for each disease. So far as the severe diseases are concerned the results are only such as might be expected, but the figures are really surprising with regard to negligible mottle and mild mosaic. It will be noted, too, that the reduction in yield is almost entirely restricted to the ware group. In addition to this the run of ware in the disease groups was much smaller than the run from the healthy plants.

The results obtained in respect of Arran Chief were very similar, the percentage reductions in yield being 16, 27, 34 and 62 in respect of total yield, and 16·6, 36, 40 and 75 in respect of 2-in. ware for negligible mottle, mild mosaic, border-line severe mosaic and severe mosaic respectively.

The figures obtained for the yields of individual plants were

analysed statistically and, although it is not proposed to detail the results, it may be of interest to note that the differences between negligible mottle and healthy were always significant.

A further experiment was carried out in 1939 to obtain further information as to the seriousness of the mild mottles which have up till now been regarded as being unimportant. Material was saved from a number of the 1938 demonstration Stock Seed plots showing varying amounts of negligible mottle and planted in a latin square in 1939, consisting of 6 replicates of 36 tubers for each stock. In all, the experiment contained 3 stocks of Majestic, 2 of Kerr's Pink, and 2 of Catriona. The following table gives the source of the stock, the condition as to health, and a comparison of the yielding capacity of the various stocks, based on the highest yielding stock as 100.

TABLE 2.

Average yield per plot of 36 plants.

Variety.	Source of Seed.	Condition of Health.	Comparative Yields. (a) 2 in ware	Comparative Yields. (b) Total	Percentage loss in (a) 2 in. ware.	Percentage loss in (b) Total Yield.
Majestic	Northern Ireland*	Fair amount of negligible mottle	100	100	nil	nil
	Scotland	Rather more mottle than above	[illegible]	97	4·6	3·0
	Cumberland	Approx. 100 per cent. distinct mottle and rather lacking in vigour	87·9	91·1	12·1	8·9
Kerr's Pink	Eire	Both stocks very vigorous, the Scottish stock containing rather more mottle	100	100	nil	nil
	Scotland		95·9	98·4	4·1	1·6
Catriona	Eire	Slight amount faint mottle	100	100	nil	nil
	Scotland	Considerable faint mottle some of which was quite distinct	90·7	94·8	9·3	5·2

* This stock contained 8 per cent. of Arran Consul rogues. These were discarded and the weights obtained for the remaining plants corrected to 36.

In every instance the healthier stock has given a higher yield than the others. In only two instances has this difference been marked, viz., between the Cumberland and the other Majestic stocks, and in the two stocks of Catriona. It is conceivable that had the best stocks been really healthy these differences would have been considerably greater.

The seriousness of the severe mosaics has long been recognised, but these experiments show that mild mosaic and negligible mottle

are also really serious, probably much more serious than severe mosaic when it is considered how very prevalent they are even in crops certified for health. Indeed, certain varieties, such as Kerr's Pink, Witchhill and Royal Kidney, are invariably contaminated with virus X, and others, such as Golden Wonder, Immune Ashleaf and Catriona, are invariably contaminated with A. Further, it should be remembered that viruses X and A, the cause of these mottles, are also responsible for severe mosaic when in combination.

Control.—So far as Scottish conditions are concerned, therefore, the main factor in the control of mosaic diseases lies in the control of viruses X and A, the former being much more prevalent than the latter. The ideal method of control lies in the production of varieties which are virtually immune from viruses X and A (*i.e.* those which react with top necrosis when grafted with a scion infected with X or A). The old varieties, King Edward, Epicure, Ninetyfold, Edgecote Purple, and International Kidney, and the recently introduced Craig's Defiance, are all virtually immune from viruses X and A, whilst a large number of varieties are virtually immune from A if not from X, *e.g.* Kerr's Pink, Herald, Dunbar Standard, Abundance, Up-to-Date and British Queen. By using virtually immune varieties as parents a large proportion of virtually immune seedlings may be obtained. So far no variety is known to be virtually immune from virus Y, so that there is no similar method of controlling this virus by breeding. At the present time, however, the problem is to maintain maximum production with the varieties to hand, and this can best be done by using only the highest grades of seed. Stock Seed and "A" grades are to be recommended, and these should be grown in the best conditions of isolation possible, particular care being taken never to plant varieties carrying virus X alongside varieties carrying virus A, as there is the possibility of an interchange of virus resulting in the appearance of severe mosaic in either or both stocks. In addition to these precautions careful roguing is necessary at all times, an operation most likely to prove successful if carried out as early in the season as possible. When roguing, care should be taken not only to remove and destroy all tubers from diseased plants, but also to remove and destroy the diseased plants themselves. It should also be possible to build up virus-free stocks of most varieties, but this is rather a slow process and could only be done on a comparatively small scale.

Leaf Roll.—Experiments were also carried out with leaf roll on the varieties Golden Wonder and Arran Consul, the methods being as indicated for mosaic. Over the two years it was found that in Golden Wonder the reduction in ware was 93 per cent., and 75 per cent. in the case of Arran Consul. These figures are

in fairly close agreement with those of other writers on the subject (2, 3, 4, 5 and 6).

Wildings.—An experiment following the layout described for mosaic was carried out with the variety Kerr's Pink. Three types of wilding were tested, 1, semi-wilding; 2, wilding; and 3, wild wilding. A separate experiment was carried out in 1939 and 1940 with the feathery wilding, and the results have been incorporated in Table 3. Some description of these may be necessary. The semi-wilding plant has 4 or 5 strong stems which, apart from some reduction in the number of leaflets, are nearly normal, but has in addition a number of thin spindly stems arising from about the base of the main stems. The plant is as tall and vigorous as the normal but flowers less freely; it matures at the same time as the normal plant. Wilding is a low-growing type with numerous non-branching stems; leaflets are rounded, there are only rudimentary secondary leaflets and the flowering parts are completely absent. The wild wilding is very similar to the wilding, but has a much larger number of thin stems and is taller in habit. The feathery wilding, known for some years as " feathery variation," is very stemmy, but here the resemblance to wilding ends. Leaflets, instead of being rounded and few in number, are numerous, narrow and pointed; they do not flower, however, or only very infrequently; this type is rather earlier maturing than the normal plant.

TABLE 3.

Wildings in Kerr's Pink. Average yield per root in ounces.

1 Type of Plant	2 No. of Plants.	3 Over 2 in.	4	5 1½–2 in	6 1¼–1½ in.	7 Chats	8 Total	9	10 Percentage loss in Total Yield.	11 2 in. ware
Normal	96	35·9	100	9·3	2·1	0·5	47·8	100	nil	nil
	96	35·0	100	10·1	1·9	1·0	48·0	100	nil	nil
Semi-Wilding	24	9·3	25·9	25·3	7·2	1·6	43·4	90·8	9·2	74·1
	96	17·1	48·8	23·0	6·3	2·1	48·4	100·9	+0·9	51·2
Wilding	5	nil	nil	12·2	16·4	2·8	31·4	65·7	34·3	100
	88	10·3	29·3	15·8	3·6	1·4	31·1	64·8	35·2	70·7
Wild Wilding	19	0·6	2·3	8·1	9·7	2·3	20·7	43·1	56·9	97·7
	74	2·0	5·6	17·7	15·1	7·4	42·2	87·8	12·2	94·4
Normal*	216	48·0	100	5·7	3·2	0·6	57·5	100	nil	nil
	216	44·4	100	2·9	2·7	0·7	50·7	100	nil	nil
Feathery	432	15·1	31·5	14·6	16·9	3·0	49·6	86·3	13·7	68·5
Wilding*	216	6·2	14·0	9·8	16·9	6·8	39·7	78·3	21·5	86·0

Notes—For explanation of Table see Table 1.

* The produce from the experiment comparing the Feathery Wilding with the normal plant was actually dressed over 2 in., 1¾ in. and 1½ in. riddles.

Little comment on yields is necessary except to point out that, although the total yield from wilding types may not be much less than that from a normal plant, the yield of ware is very poor indeed; even the type most nearly approaching normal yields less than half a crop of ware, and even then the ware is of very poor size. It is of interest to note that in the true wilding types the tuber shape alters, in that the tubers are longer and less deep eyed than the normal, and the wilder the type the more marked the difference in shape.

Transmission of Virus Diseases—For a number of years samples of diseased stocks have been demonstrated at East Craigs, these samples being obtained from crops which were inspected but not certified. These samples are examined early in the season for virus diseases, and the figures so obtained are compared with those of the previous year's inspection. In this way is obtained information as to the increase of virus disease from one year to the other. These figures vary according to the area from which the crop has been drawn, the increases being least in high-lying, exposed areas remote from towns, and greatest in the crops drawn from districts in the vicinity of towns or in the less-exposed, low-lying, drier areas The increases also vary with the season, and may be very great following a dry, warm season, or very small following a cold, rainy season On the average, however, it can be taken that severe mosaic will increase two to threefold, and leaf roll fourfold, from one year to the other.

Summary.

The presence of virus induces earlier ripening.

Negligible mottle, usually caused by mild strains of virus X but also by virus A, may reduce the yield of ware by 16-25 per cent.

Mild mosaic, normally caused by virus X but also very occasionally by virus A in combination with mild strains of virus X, may reduce the yield of ware by 30-40 per cent.

Border-line severe mosaic, usually caused by the combination of viruses A and X, and also by the severe strains of X, may reduce the yield of ware by 40-50 per cent.

Severe mosaic, caused by the combination of virus A with the severer strains of X, also by virus Y either alone or in combination with A or X (note, Y is relatively uncommon in Scotland), may reduce the yield of ware by 65-85 per cent.

Leaf roll, caused by the leaf roll virus, reduces the yield of ware by 75-90 per cent.

The wilding group, including true wildings and other stemmy variations, reduces the yield of ware by 50-95 per cent.

Severe mosaic increases on the average by two to threefold, and leaf roll fourfold, from year to year.

Mosaic diseases can be controlled by 1, production of varieties virtually immune from viruses A and X; 2, use of highest grade seed; 3, satisfactory isolation, taking particular care never to plant X carriers in proximity to A carriers; 4, thorough roguing, particularly in the early part of the season; and 5, roguing for mild mosaics as thoroughly as for the severe diseases.

Leaf roll and wildings may be controlled by 1, use of high grade seed, and 2, early and thorough roguing.

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RED CORE DISEASE OF THE STRAWBERRY.

Robert D. Reid.

Few horticultural crops have experienced greater vicissitudes during the past twenty years than the strawberry. Before the 1914-18 war the culture of this crop was not attended by any special difficulties which the exercise of ordinary cultural care could not overcome, and the chief worries of the commercial grower were concerned with questions of labour or price. In the period from 1920 onwards increasing difficulty in growing the crop has been experienced, coupled with many cases of complete failure under circumstances which previously would have been such as to ensure success.

One of the first districts to experience this was Lanarkshire, and the trouble became so widespread there as to give rise to the name "Lanarkshire" disease. Critics were not slow to suggest that cultural conditions might be largely responsible, but the facts have not supported this view (1, 2, 3). Results in the last twenty years have shown that the strawberry troubles are much more widespread, and may indeed be regarded as of world-wide significance, as in very few countries where this crop is grown are conditions as satisfactory as they were formerly.

Numerous workers have given attention to this unsatisfactory condition of the strawberry-growing industry in many different districts, and the varying results of their investigations have led to much confusion (4, 5). It should be understood that this crop is subject to a large number of different diseases, and that the position has been considerably worsened by the widespread distribution of these diseases. In the opinion of the writer this has been mainly brought about by the rapid development of transport having made possible rapid and extensive distribution of plants from area to area.

The possibility of these diseases having spontaneously materialised is hardly admissible, and one feels justified in believing that each may have been in existence for a very long time in a particular locality where natural conditions may have to a great extent neutralised the harmful effects. With the extensive redistribution of stocks after the last war varieties were brought into new areas where probably the various diseases found conditions more congenial to them, and their destructive forces were accordingly increased. Furthermore, in many cases diseases from widespread sources were brought together and in combination produced devastating results. It is unfortunately true that many growers, in their efforts to secure " disease free " stocks of plants by purchasing from distant sources, introduced new diseases not previously existing on their own farms.

The position is yearly becoming more complicated, and to understand the difficulties of any one area it is better to go back a little to the time when troubles were less complicated.

The purpose of this article is to give some details of the work that has been done in the attempts to find a control for one of these troubles, viz., the " Red Core Disease," long known as " Lanarkshire Disease."

Probably the first case definitely recorded was investigated and reported upon by the late Mr D. V. Howells in 1921. In this outbreak several varieties had been brought from the south of England and planted on land which had only once before been under strawberries. These were planted in the usual way in the spring, and runners were distributed the following spring to a large number of farms in the locality. A few weeks later severe collapse of the fruiting plants took place, leading to the complete failure of the crop. Subsequent investigation proved that the disease had followed the distribution of runners from this stock. Since this outbreak the disease has steadily progressed until the acreage under strawberries in the Clyde area is now only a fraction of what it was.

Briefly, the disease in the field takes the form of more or less rounded patches of stunted, unhealthy discoloured plants. These

patches, which rapidly increase in size, are often situated on the low-lying portions of the field or on badly-drained areas. Bad drainage, while it accelerates the collapse of plants, is not a necessary factor, as the disease may occur over a wide range of soil conditions. The diseased plants show, on lifting, a depleted root system, many of the roots have a brown tip, and when the outer portion (cortex) of the roots is scraped off a reddish-brown core is exposed. Further details of the history and description of this disease can be found in earlier publications (6, 7, 8). It should suffice here to emphasise that distribution of diseased runners is always followed by outbreak of disease, that land once infected remains so for a very long time. While soil moisture is necessary for its spread, excess of water due to impeded drainage is not an essential factor, but may contribute to the severity of the attack and accelerate the collapse of the plants.

The causal fungus, which was discovered and described in 1929 by Mrs Alcock (6), was named *Phytophthora Fragariae* by Hickman, who also finally established its pathogenicity (9). The disease is now known to exist in eighteen counties in Scotland, in some of which only a few outbreaks are known, in five counties in England, and in eleven States in U.S.A. (10, 11).

The pioneers in this work were members of the horticultural staff of the West of Scotland Agricultural College, particularly Mr Dudley V. Howells. Later, in 1929, Mrs N. L. Alcock, Plant Pathologist to the Department of Agriculture for Scotland, collaborated with the College, and since that date the work has been carried out as a joint effort by the Department and the College.

Three methods of control have been investigated, namely (1) cultural improvements, (2) chemical treatments, and (3) selection and breeding for resistance.

(1) *Cultural Improvement.*—Much of the earlier work, both of the investigators and of countless private and commercial growers, followed this line. Altered systems of cultivation, rotation, manuring, times and methods of planting, etc., were tried. In many cases these resulted in greater health of the plant for the first few months of its life, but seldom, if ever, had any material effect upon its susceptibility to disease. There is no doubt that in many cases the standard of cultivation could be improved, and such improvement is very desirable, but it would be a big mistake to suggest that cultural improvement in itself will eliminate the disease. It is an outstanding fact that some of the best cultivators were among the first to suffer misfortune from the advent of this disease.

(2) *Chemical Treatments.*—The earlier work carried out by Mr Howells and his assistant, Miss Copeland, consisted largely

of attempts to control the disease by chemical means, and very many materials were tested. Applications to the soil before and after planting, treatment of plants before planting, and applications to the growing crop were all included in this research.

This line of work was followed for about six years, the writer continuing from the point where Miss Copeland left off in 1930. The work proved difficult and disappointing. On many occasions certain materials—particularly those belonging to the cresylic acid group—seemed to have a wonderful effect, suggesting a cure or a prevention of infection, but time after time this improvement of health proved to be only temporary, the effect seldom lasting more than six or eight months and never sufficiently long to ensure a normal crop. Moreover, the very considerable expense involved in these treatments made their ultimate adoption uneconomical even had they proved as successful as hoped. By the winter of 1932-33 it was considered that there was little hope of achieving permanent success by the use of chemicals, and these tests were gradually discontinued. No field trials have been carried out for several years. Any chemicals which may be considered as having possibilities are now tried under conditions of pot culture, but this is now a very minor side of the work.

(3) *Selection and Breeding for Resistance.*—There were early indications of some variation in varietal resistance, and from the outset the hope was entertained that some variety possessing immunity might ultimately emerge. Very early in the investigation it was observed that certain varieties and certain rogues seemed less susceptible, although further observation generally indicated that this feature was of a temporary nature, even these resistant varieties going down later. In the earlier observations the well-known Green Stipuled Rogue (12) was noticeably vigorous in diseased fields. Amongst named varieties "The Duke" seemed generally to stand a year longer than most others. In an effort to follow this up many varieties were introduced from other areas and other countries. The introduction of the continental varieties "Oberschlesien" and later "Pillnitz" seemed to have effected a definite element of resistance. In the last-mentioned variety this resistance was very high, although it was by no means completely immune. Unfortunately these varieties were, in most cases, themselves infected with virus diseases when brought in to the district, and were therefore partly responsible for the introduction to the district of the new series of virus diseases Yellow Edge and Crinkle, which have so complicated the issues.

Those responsible for the research work have always kept the possibility of obtaining immunity very much in mind, and Mr Howells made a collection of every variety possible, including an

extensive collection of American varieties. Plants were obtained from British sources, and from Norway, New Zealand, France, U.S.A., Canada, and other places. Many old and obscure varieties and more recently introduced new varieties were added whenever these were found. In addition, rogues which appeared to be slightly resistant were collected from various sources, and limited programmes of crossings were carried out by Miss Copeland and by Miss Millen of the West of Scotland Agricultural College. Claims were repeatedly made by others that certain varieties or strains were proving resistant, and these claims had to be tested.

When the present writer took over this work in 1930 he was given custody of, and extended, the above collection as well as a small number of seedlings raised by Miss Millen. These were all tested under the most severe conditions which could be applied. One seedling passed the test so successfully as to convince the workers that real resistance was at last a possibility.

The seedling, which was known as 5a, retained its immunity throughout the period of test, and was used as the basis of the original breeding, but was itself singularly unprofitable. The fruit it produced was small and poor in quality, and subsequent experience suggested that this variety may have always been affected by virus disease. Seedlings bred from it, while frequently resistant to Red Core Disease, had to be abandoned after several years because of poor commercial qualities.

Miss Millen's records showed this seedling (5a) to have been derived from a cross between an unknown rogue and an obscure named variety of which little was known. This latter ultimately yielded a clonal selection which proved highly resistant and produced good fruit, but was severely infected by virus troubles. Receiving the field number "52," it was extensively used in crossing, and has been the basis of most of the breeding since 1933. Crossings using this selection have generally produced about 36 per cent. of seedlings resistant to Red Core Disease.

It will be readily realised that plant breeding is a long continuous piece of work, never yielding sudden or spectacular results and never showing anything like finality. Owing to the many factors involved, testing must be prolonged over many years before a variety can be released, and practical considerations make the rapid increase of stocks undesirable until the variety is proven. In the meantime the plant breeder is, year by year, making fresh crosses, incorporating new ideas which have been suggested by experience This constant production of new seedlings, each in turn being subjected to newer and more drastic tests, is a severe strain on the raiser's loyalty to his first productions, as his personal inclination each year is to discard the earlier productions in favour

of the better which appear to be at hand. Meantime growers who have seen these earlier products are pressing for their release.

These remarks are by way of explanation of the present position where, in response to an urgent public demand, certain seedling varieties have been released to the trade, in the knowledge that they have not reached the ideal, and in the hope that it may be possible shortly to release others which may prove superior to and replace the present issue.

After eight years of test and the gradual elimination of unsatisfactory seedlings, five varieties have now been released. A further two varieties from this batch are still under test, and one may yet be released if results justify this step.

The main point of interest in these varieties is their reaction to disease. During the first five years of their test no trace of infection was ever found amongst them and it was believed that complete immunity had been achieved, but during the last three years, when the amount of runners handled has run into hundreds of thousands, occasional plants have been found on which a slight degree of infection, usually extending for only a short distance into the tissues, was seen on one or two rootlets. The damage is frequently associated with very unfavourable soil conditions, and is accompanied (or preceded) by invasion by some of the weakly parasitic fungi which are so plentiful under unfavourable soil conditions. The total proportion of plants affected has been very small, but the possibility of resistance becoming progressively less cannot be overlooked.[1]

Under practical field conditions no case of the breakdown usually associated with Red Core Disease has been found in these varieties, and the contrast with ordinary commercial varieties grown as " controls " has been most marked. They have now been tested very widely throughout the West of Scotland, and the results have generally justified the belief that they are virtually immune. Independent tests by Anderson, of U.S.A., who has been interested in this disease in America (10), and who tested four of these varieties in Illinois, have shown them to be 100 per cent. resistant under American conditions. Darrow also tested them in Maryland with similar results. Hickman carried out tests in Kent under the most severe conditions he could devise, and found three varieties completely resistant and a fourth showing a very slight infection similar to that found in Scotland. This he regarded as commercially unimportant.

The reaction of these varieties to virus diseases is less satis-

[1] Since this article was written some evidence has appeared which suggests that in certain cases a breakdown in resistance to Red Core may possibly be more serious than was anticipated. In the majority of cases, however, health is still being well maintained.

factory. They are found to be definitely very susceptible to the virus diseases of Yellow Edge and Crinkle, and it has not been found possible to keep them free from these diseases. The position has been worsened by some of the growers who have been handling them, having planted them in close proximity to "carrier" varieties such as "Oberschlesien" and "Huxley Giant." In consequence some of the stocks are fairly heavily infected with virus diseases. It is emphasised that anyone who attempts to grow these varieties should grow them well away from other varieties, and should practise careful and frequent "roguing," removing all suspected plants.

Notes on their fruiting characters are given below. In general it may be stated that their cropping is up to commercial standard, but they are rather softer than could be desired. In many cases this has not been unduly noticeable and market reports have been satisfactory. In other cases, under conditions of excessive rains, much loss has been experienced from fruit rotting on the plants. With these, as with the older commercial varieties, some variation in results from place to place is to be expected, and growers would be well advised to restrict their plantings to a small experimental area until they find varieties most suitable for their own particular conditions.

Auchincruive 1.—This is a second early variety of good colour, size and shape. Flavour is sweet, pleasant, but not very full. Crop is very good, quality is good, but skin is easily bruised, making transport damage frequent if allowed to become fully ripe, or if picked carelessly. Habits of growth and vigour have been very satisfactory.

Auchincruive 2.—A more compact grower than the above and a few days later in ripening. It carries an enormous crop of fruits which are more rounded in shape, smaller and softer in texture. In spite of this apparent softness, market reports have been unexpectedly favourable. The heavy cropping and long picking season have made this variety popular.

Auchincruive 4.—This is a mid-season to late variety. The quality and crop have proved excellent, colour, shape, flavour and carrying powers all being satisfactory. The general vigour of the plant is not so strong and it does not grow so high, but generally covers the ground well. The fruit may be considered as belonging to the Royal Sovereign type.

Auchincruive 5.—This variety closely resembles the preceding and has proved exceptionally satisfactory over several seasons. While possibly a little more acid than some of the others, it has proved an excellent market variety, and the crop, while not so

heavy as numbers 1 and 2, is well up to commercial standard. In vigour this plant is comparable with number 4.

Auchincruive 6.—This is now proving one of the most vigorous growers. Fruits are very numerous but smaller and more elongated in shape. The colour, shape and texture are very good, and flesh is red throughout. The nice bright colour was greatly appreciated in the market, but the larger proportion of small berries make it pre-eminently a jam berry.

American workers have tackled the problem along parallel lines to ours, and they were fortunate in having a local variety which was found to be immune. This variety is known in America as "The Aberdeen," but is not related to the "Aberdeen Standard" and "Aberdeen Favourite" grown in this country. Through the good offices of Dr H. W. Anderson it was found possible to import quantities of this variety in 1938 and 1939, and large-scale tests have proved it to be resistant to Red Core Disease in this country also. This result is interesting as confirming the opinion that the causal organism might be identical in both countries. This variety has not a very good reputation in America because of its fruiting qualities, and results here, while better than reports from its country of origin might suggest, still leave something to be desired, particularly with regard to flavour. It is superlatively good for jam making. Limited supplies of this variety are available and have been released under the name "American Aberdeen" along with the five seedling varieties described above.

The foregoing remarks on these varieties will have given some indication of the problems which have had to be faced in arranging subsequent breeding programmes. These include the concentrated attempt to introduce better fruiting qualities, an even greater degree of resistance to Red Core, and an attempt to introduce resistance to virus diseases. Recent seedlings have a strong factor for virus resistance, perhaps of the "perfect tolerance" type rather than complete immunity, which should be the real object. The earlier work and the later have been, to some extent, opposed, inasmuch as, while the aim of the "Red Core" resistance combined with fruit production has been constant, the development of the earlier varieties depended upon their being kept as free as possible from the risk of infection by virus, while the raising and development of the later seedlings called for resistance to virus, which can only be tested by exposure to infection. The attempt to run these two programmes concurrently has not lessened the difficulties of the work.

Without taking into account unsuccessful crosses, or batches of seed which were infertile, some 430 separate batches of seedlings have been raised. These have given close on 30,000

seedlings, some of which have had a long, some a short, test. About 24,000 of these have had their performance individually recorded. The initial discarding factor was usually that of susceptibility to Red Core Disease. Following upon that they were discarded for actual virus infection, then for defects in commercial qualities.

In conclusion it should be stated that this investigation has been financed by the Development Commission, the schemes of work being approved annually by the Agricultural Research Council, and without this assistance the work could never have developed.

Grateful acknowledgment is made of the signal assistance rendered by many who were interested, and by the staffs of colleges and research stations. In particular, however, deep appreciation of the work of the late Mr Dudley V. Howells must be recorded. The direction of the work and far-sighted policy of Mr Howells and Mrs N. L. Alcock have contributed very largely to the present results. Many commercial growers have lent, free of charge, land, tools and labour, and have also contributed cash subscriptions in support of the work.

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LAND DRAINAGE (SCOTLAND) ACT, 1941.

THE purpose of this Act, which received the Royal Assent on 26th March, 1941, is to enable the Secretary of State during the present war to carry out arterial drainage works in various parts of Scotland where agricultural land is unproductive, or nearly so, because of its liability to floods. It is a war-time measure to meet the need for maintaining and increasing food production.

Hitherto there has been no effective way of securing agri-

cultural improvements of this kind in Scotland, except where landowners and others interested can come to an agreement for the purpose, and questions of compensation can be mutually adjusted. A compact of this nature is difficult—especially without the initiative and assistance of a central authority—and no doubt expensive for those concerned in relation to the financial benefits they could expect to derive.

In Scotland there are no Catchment Boards or Drainage Boards charged with the duty of maintaining arterial drainage systems and protecting lands from floods.[1] In this Scotland differs from England where, since Tudor times, the history of administrative authorities with jurisdiction in river basins has been continuous. Legislation which has served to develop the powers and duties of these Boards has been continuous even to the past year. Their powers include the rating of lands within their catchment areas to meet the cost of their works and administration.

The Scottish problem is different and not so serious. The rivers are not long and usually their fall is good. The cases of widespread flooding or of saturation of lands are mostly of a local character. Such injury as occurs is due mainly to the fact that fall is not uniform, often because of barriers of rock in a river bed or flood water temporarily held up in more level stretches. The damage falls within definite and limited areas in relatively close proximity to particular sections of the rivers. In such circumstances a relationship involving financial liability cannot be reasonably established between lands directly affected by flooding and other lands in the same catchment area but at a distance and completely free from injury. It is impracticable, therefore, to deal with Scottish problems of agricultural arterial drainage in the same way as is done in England. This situation was accepted by Parliament when it passed the Land Drainage (Scotland) Act, 1930. Section 3 of that Act enabled the Department of Agriculture to prepare and settle schemes only for a period of five years from the passing of the Act. By a later Act, passed in 1935, this power was extended for two years until 1937; since then it has lapsed. Although a number of schemes were investigated and prepared only three schemes were proceeded with. Financial stringency and the elaborate and lengthy procedure required by the Act combined to limit the amount of effective action that could be taken within the period. For example, after a scheme had been prepared it took from six to nine months to get it in operation if, indeed, after all considerations were taken into account, it were decided to do so. The scheme required to be laid before the Houses of Parliament for 28 days. If during

[1] There is one small drainage authority in Perthshire that controls the Pow of Inchaffray—it derives its powers under a local Act.

that period no address was presented to His Majesty by either House praying that the scheme should be annulled, the Department might then decide to proceed with the works, intimating their intention to all affected parties.

It was the experience of food production requirements in the last war that called attention sharply to agricultural areas which, owing to floods or risks of flooding, were practically derelict or could not be efficiently cultivated. In the present war the intensive search of the Agricultural Executive Committees has revealed many areas where effective large-scale drainage operations in rivers could add materially to the agricultural output, but which could not be improved until powers comparable to those of the Act of 1930 were restored.

The main operative part of the 1941 Act is Section 1. It provides that, if the Secretary of State is satisfied, by a Report from an Agricultural Executive Committee that drainage operations are necessary to reclaim agricultural land or to make it fully productive or to protect it from danger of flooding, he may execute such drainage works and maintain them. Before executing any works a draft scheme has to be prepared setting out the proposed works, the area to be affected, the estimated cost, the amount of the estimated cost to be recovered from owners on the score of betterment, the estimated cost of maintaining the works and its apportionment among the owners concerned.

The works in view are defined in Section 7. What is contemplated mostly is the deepening of the bed of rivers by excavation, the removal of natural obstructions such as rocks, and artificial ones such as weirs and caulds, the making of embankments and diversion of channels. It will be noted that the works are maintained in perpetuity.

Further conditions of any scheme are that the estimated cost of the work is not unreasonable having regard to the benefits to agriculture which would accrue, and does not exceed ten pounds for each acre of agricultural land to be benefited by the operations. Those conditions will prevent any arbitrary use being made of the powers which the Act confers.

The Act also provides that the scheme will be advertised and be open for inspection. Notice of it will also be served on all owners and occupiers of land within the area, as well as on other persons who may be affected. As far as possible, therefore, it will be known in advance precisely how the owner of land will be affected by the proposed works. He will be allowed a suitable period within which to lodge objections and to intimate claims for compensation for any damage that he considers the scheme may cause to his interests.

Before proceeding with any scheme the Secretary of State

must consider objections and claims which have been lodged within a reasonable time. If any of these claims that relate to compensation or to the amount of the value of betterment, or of annual maintenance charges apportioned to any land, cannot be settled by agreement, they will be referred to the Scottish Land Court for determination. But the Act enables the Secretary of State to carry out the work without waiting for complicated questions of this kind to be settled.

The cost recoverable by the Secretary of State in respect of the capital expenditure and the estimated cost of maintenance is apportioned amongst the various lands, having regard to the benefit expected to accrue to them, but must not exceed the value of this benefit. In estimating the value of such benefit account has to be taken of any probable increase in the value of the lands, any depreciation expected to occur if no such drainage works were undertaken, any benefit by way of relief from expenditure on drainage or damage from flooding, and any expenditure incurred by the owner in respect of drainage works which are being carried out. The sums payable towards the capital works and maintenance are levied and collected by the rating authority.

If any owner so desires, the sum payable by him towards the capital works may be paid by means of a rate sufficient to discharge the capital charge, together with interest at such a rate as the Treasury may decide, in a period not exceeding 30 years.

An owner may recover from the occupier in occupation at the date of completion of the works an annual payment as the Secretary of State may determine.

The cost incurred in maintaining the works up to the estimated cost of maintenance specified in the scheme is recoverable annually according to the apportionment. Should the cost of maintenance exceed that specified in the scheme the balance has to be borne by the Secretary of State.

A further safeguard in regard to compensation is also provided by the Act. If within two years of the completion of works a person finds that he is suffering consequential damage which could not reasonably have been foreseen by him at the time when the scheme was prepared and notified to him, he will be entitled to make a claim. No claim for compensation may be founded on alleged loss of pleasure or amenity.

Any compensation agreed on or determined becomes due when the Secretary of State intimates that he has decided to proceed with the works. The amounts recoverable from the owners (*i.e.* betterment value) become due when the works are completed.

The Act will expire with the Emergency Powers (Defence) Act, 1939, without prejudice to the completion of schemes settled before that date.

TAXATION AND THE FARMER.

The direct taxes which affect the farmer are Income Tax, National Defence Contribution and Excess Profits Tax. There is a strong resemblance between these three taxes, but they differ from each other both in the type of income on which they are levied and in the weight with which they are applied. Income Tax is levied on all incomes whether earned or unearned, whilst National Defence Contribution and Excess Profits Tax are levied on one section only of earned incomes, namely those arising from trade or business. The wage or salary earner may be affected by Income Tax but is not concerned with National Defence Contribution or Excess Profits Tax. Income Tax is chargeable on all levels of income from £110 upwards. National Defence Contribution and Excess Profits Tax are levied only on the higher ranges of income.

Income Tax.—For Income Tax purposes all incomes are classified into one or more of five divisions, known as Schedules A, B, C, D and E, but only three of these, Schedules A, B and D, immediately concern the farmer, except in so far as he may be in receipt of an income not arising from the farm.

Schedule A is the property schedule, and the tenant farmer pays the tax when it is levied on him, and then deducts it from his next payment of rent. A fairly general practice in Scotland, however, is for the property tax notice to be sent direct to the owner, and the tenant farmer is not affected. In the case of an owner-occupier the income accruing from ownership is assessed by making certain deductions from the annual value. The amount thus calculated is treated for tax purposes as part of the farmer's income.

Schedules B and D relate to assessments of profit. Until 1941 a farmer's profits were assessed under Schedule B, unless he elected to be assessed under Schedule D. Under Schedule B it is assumed that the profits are equal to the full rent less the full annual value of any cottages included in that rent. Under Schedule D the assessment in any year is reckoned to be equal to the actual profits of the year before. In opening the 1941 Budget, however, the Chancellor of the Exchequer announced a change in respect of assessment of farmers' profits for Income Tax. It is now proposed that farmers with a farm or farms rented at more than £300 shall no longer have the option of being assessed under Schedule B, but must be assessed under Schedule D. In the case of partnerships the limit is £300 per partner, and so a farming business with two partners with an annual rent of as much as £600 will still be assessable under Schedule B, unless the partners elect otherwise.

National Defence Contribution and Excess Profits Tax.—For the purpose of assessing the farmer's liability to these taxes the profits are no longer considered to be equal to the rental value of the farm. If the Inland Revenue Authorities have reason to believe that any farmer, no matter what the rental value of the farm, is making sufficient profit to become liable to taxation under these heads they may ask to see his accounts, and if he is unable or unwilling to produce them may assess his profits at such a figure as they think fit.

The National Defence Contribution is a tax of four per cent. (five per cent. in the case of a trade carried on by a body corporate) on the profits. It is chargeable only when the annual profits exceed £2000. Where the profits exceed £2000, but are less than £12,000, they are reduced by a sum equal to one-fifth of the difference between the amount of those profits and £12,000. The tax is limited to the five-year period 1937-42. It is a tax on total profits.

Excess Profits Tax, on the other hand, is a tax on that part of the profits which is additional to the amount made in a stated basic period, with the proviso that it does not affect incomes below a certain limit.

For the purposes of the Excess Profits Tax a person may elect to be assessed either from (*a*) a profits standard or (*b*) a non-profit or minimum standard. Under the profits standard the tax is charged on the difference between the profit in the chargeable period and the profit in the standard period. The profit in the standard period is the profit in one or in a combination of the years 1935, 1936 and 1937. Arrangements are provided to adjust this profit on account of changes in the amount of capital employed in the business. Under the non-profits or minimum standard the tax is charged on the difference between the profit in the chargeable period and a minimum standard. This standard is £1,500 in the case of an ordinary farmer or such greater sum, not exceeding £6,000, as is arrived at by allowing £1,500 for each working proprietor in partnership. The rate of tax is 60 per cent. of the difference calculated as above for the year 1939-40, and 100 per cent. of the difference in subsequent years.

It is now proposed that a part of both Income Tax and Excess Profits Tax shall be returned to the taxpayer at the end of the war. In the case of Income Tax this post-war credit is equal to the additional amount of tax that is payable as a result of the reduction in the personal and earned income allowances which came into operation in 1941-42. It is proposed to continue it as long as these reduced allowances are in force, but the credit for any one year will be limited to £65. The post-war credit in the case of Excess Profits Tax is 20 per cent. of the amount paid,

although in this case certain limitations as to the use of the money, when repaid, will be imposed. It is payable for all the years in which tax is payable at the rate of 100 per cent.

In calculating profits for Income Tax purposes any Excess Profits Tax or National Defence Contribution paid may be treated as an expense and deducted from the profit. Where both Excess Profits Tax and National Defence Contribution would fall to be paid, the amount of Excess Profits Tax is calculated as if there were no National Defence Contribution, and the National Defence Contribution is calculated as if there were no Excess Profits Tax. If the National Defence Contribution thus calculated is higher than the Excess Profits Tax then the former only is payable. If the opposite is the case then only Excess Profits Tax is payable.

Keeping Accounts.—Until the imposition of National Defence Contribution in 1937 and Excess Profits Tax in 1939 the farmer was in a privileged position in so far as the production of accounts for tax purposes was concerned. Now this privileged position has largely disappeared. It is unlikely that farmers working on a small scale will be asked to submit their accounts to the Inland Revenue Authorities, but there is always a possibility that the accounts may be demanded for the purposes of assessment of National Defence Contribution and Excess Profits Tax. In the case of larger farms accounting records are almost certain to be required in connection with these two taxes, whilst farmers with businesses falling within the Schedule D limits as described above must be prepared to furnish accounts to the Inland Revenue Authorities as a matter of course. In this latter case farmers should take steps to have accounts available for the year 1940-41, as these are the accounts on which the 1941-42 assessment will be based.

This is not nearly such a difficult task as it sounds. Many farmers imagine that book-keeping in any form requires an inordinate amount of skill in the manipulation of figures, an enormous amount of writing, and the burning of immense quantities of midnight oil in order to "balance the books." This is not so. Most farm businesses are of a type which do not demand a complicated system of book-keeping. Only very rarely is a Ledger System necessary, and in the majority of cases the essential records for Income Tax purposes can be kept in a simple Cash Book, divided into Receipts and Payments. Then, by observing the following very simple rules, book-keeping needs are satisfied:—

(1) Whenever a sale is made and the money received enter the transaction in the Receipts section of the Cash Book.

(2) Whenever money is paid out enter the transaction in the Payments Section of the Cash Book.

The above rules are most easily followed if all transactions are entered initially in a diary carried by the farmer and subsequently transferred at regular intervals to the Cash Book. For the sake of convenience the main Cash Book referred to here may be supplemented by a number of subsidiary books, each to cover some separate item, such as eggs or wages. The totals of these books should then be transferred at weekly or monthly intervals to the main Cash Book. The nature of the particular business would determine whether books of this kind were necessary. It is easier to keep accounts if payments are made as far as possible through the bank, and if all cheques received are paid into the bank. If this is done consistently the Bank Pass Book may be used as a check on the farmer's own Cash Book.[1]

Valuations.—In addition to following the above rules, a valuation of the live and dead stock on the holding must be made at the beginning and end of the accounting year. The accounting year may be commenced at any time. In so far as a general principle can be laid down in respect of valuation, it is that assets shall be valued at cost price or market price if this be lower. The calculation of cost price is in many cases impossible, and the practice has gradually been adopted by farm accountants of valuing saleable assets at market price less a reasonable cost of marketing, and, in the case of breeding stock, at a constant price based on prevailing market values. Implements and equipment may be valued at cost price, less depreciation. No detailed valuation of unexhausted manurial residues is necessary, and the Inland Revenue Authorities will normally accept in lieu a statement from the farmer that the value of this item has undergone no significant change between the beginning and end of the year, or, alternatively, that it has changed by a stated amount. The underlying assumption throughout, however, is that the values arrived at in this manner approximate to cost of production.

In normal cases, therefore, the accounting needs of the Inland Revenue Authorities may be met by choosing a suitable valuation date, making a valuation on that date, entering the transactions for a year in accordance with the above rules, making another valuation on the last day of the accounting year, and then applying to the local Tax Inspector for a form on which to enter a summary of the above records. The farmer will subsequently be provided with a form on which to enter the particulars (such as number

[1] *Bulletin* No. 58, "A Simple System of Farm Book-keeping," obtainable from H.M. Stationery Office, 120 George Street, Edinburgh, price 8d. (post free), provides a helpful description of farm book-keeping technique. The Agricultural Economists stationed at the Agricultural Colleges in Edinburgh, Glasgow and Aberdeen are also available to give advice to farmers in connection with accounting and farm management problems.

of children, insurance payments, etc.) necessary for calculating the amount of his total income which is exempt from tax, and will finally receive a note of tax payable by him and the date on which it should be paid.

There is no reason why the farmer should not carry out all these operations himself. The essential recording is not difficult, and method and regularity in applying the above rules are all that is required. The Inland Revenue Authorities do not insist, and have not the power to insist, upon the production of accounts prepared by a professional accountant. All they require is a *satisfactory* account. They issue a form of account on which the farmer may submit his financial records. This form is designed purely to help the farmer. The Inland Revenue Authorities never insist upon its use, and will accept instead any satisfactory statement.

Example.—So far, no suggestion has been given of the actual amount of tax that would be payable at different income levels. This varies according to individual circumstances, and full details are supplied on the forms issued by the Inland Revenue Authorities. All the farmer has to do is to supply the facts, and the adjustments and calculations are then made for him. There is not space here to describe all the possible adjustments that circumstances might render appropriate to all the different income levels, but the following summary and example may be interesting and suggest how a rough assessment of the individual position may be made.

In the first place add up the total income from all sources other than farming. Then, if the farm is rented at £300 or less, add on the rent of the farm. If the farm is rented at more than £300, add on, instead of the rent, the actual profit made, as shown by the accounts in the year prior to that for which the assessment is being made. If an owner-occupier, the annual value, less certain adjustments for mortgage interest, etc., must be added on to the figure obtained above. The resulting figure is known as the total statutory income. In order to obtain the taxable income from this certain deductions are permissible. Chief amongst these are a personal allowance of £80 if the receiver of the income is a single man, or £140 if a married man, £50 for each child under 16, a deduction for premiums paid for Life Assurance, and an earned income allowance equal to one-tenth of the earned income up to a maximum of £150. Thus in the case of a married man with three children under 16 and Life Assurance premium of £50 per annum, the allowances on a total statutory income for 1941-42 of £800, all earned, would be £370. This total is made up of a personal allowance of £140, allowance for three children of £150,

and an earned income allowance of one-tenth of £800. The taxable income would be £800 less £370, or £430. The rate of tax is 6s. 6d. in the pound on the first £165 of taxable income, and 10s. in the pound on the balance of £265; the total tax payable, therefore, would be £186 2s. 6d., less an allowance at the rate of 3s. 6d. in the pound on the Life Assurance Premium of £50, giving a net income tax of £177 7s. 6d. Of this sum £41 13s. 4d. would be repaid when the war is over. The post-war credit is calculated in the following manner. In the present example £265 of the taxable income fell to be taxed at the rate of 10s. in the pound. This figure was calculated by using the reduced personal and earned income allowances of £140 and one-tenth respectively. Had the previous personal and earned income allowances been used, namely £170 and one-sixth, a deduction of £303 6s. 8d. would have been possible under these heads instead of the £220 which was actually deducted. The net result of the decrease in these allowances, therefore, is an increase in the taxable income of £83 6s. 8d., all subject to tax at the rate of 10s. in the pound, and this is the amount, £41 13s. 4d. in all, which would be treated as a post-war credit.

The calculation of Excess Profits Tax and National Defence Contribution is much more straightforward. No illustrative examples are necessary, and the short description of the taxes earlier in this article should enable anyone to make a rough assessment of his own liability to such taxation.

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INTRODUCTION BY THE SECRETARY OF STATE FOR SCOTLAND

THE able men and women who have contributed to the series of short articles appearing in this *Journal* on the position of post-war agriculture in Scotland, are entitled to our thanks.

The tide of battle ebbs and flows across a distracted and an anxious world, and what agricultural and other economy will finally emerge from the clash none can foresee. Yet surely this is certain: that after the war we shall—all nations on earth—require to produce more from our soil; that we shall require the most effective processing and marketing of that produce; and that we must ensure adequate remuneration, decent housing, and more of the amenities of civilised life for the workers who raise our foodstuffs.

It is well then that we should ask how these aims may be reached. No one suggests it is possible to fill in the details of the picture with exactitude and precision, but it is well that farmers and farmworkers should give thought betimes to the future, and to the place Agriculture ought to fill in the Scotland that is to be.

And for that reason I welcome the publication of the symposium which follows.

Thomas Johnston

Scottish Office,
10th December 1941.

AGRICULTURE AFTER THE WAR.

THE contributors of the following short articles, which are printed under their respective authors' names, were invited to discuss briefly the following two questions:—

1. What should be the position of agriculture in the economic and social structure of Great Britain after victory in the War, and what should be the general policy of the State in relation to agricultural and rural life?
2. Would any modification of this policy or any special developments be desirable for Scotland?

The Department acknowledge gratefully the willing response which the writers made to their request. Publication in the *Journal* does not imply official agreement with the views expressed by them nor are those writers who are associated with certain organisations to be taken as expressing the views of those bodies.

LORD ABINGER, D.L., D.S.O., INVERLOCHY.

The primary object of the majority of the British electorate is the protection of industry coupled with high wages and cheap food. This must always be the case in highly industrialised countries. If the British farmer is to prosper he must be in a position to supply a proportion of the cheap food required. To produce food at a reasonable cost in Great Britain three things appear essential, namely, an economic wage, low distribution costs and skilful farming.

Low wages drive labour from the land and uneconomic wages ruin the farmer. Low distribution costs can best be assured by co-operation amongst the farmers themselves, but, if this is not possible, the Government can, if it thinks advisable, fix minimum economic selling prices for producers and, if necessary, reasonable purchasing prices for consumers.

The skilful farmer must take full advantage of the knowledge made available through the various agricultural colleges and research stations, and also follow and take advantage of the advance in mechanisation wherever applicable to his particular branch of farming. Perhaps it is hardly realised how many really efficient and skilful British farmers there are to-day, and were it not for lack of capital there would be a good many more.

Without making any drastic or expensive changes in the existing systems of farming as carried out in Great Britain to-day, the Government could consolidate the position of farmers by giving assistance under various headings.

Finance.—Many good farmers are seriously handicapped through lack of capital and are often unable to obtain the results

they wish for this reason. A great deal more agricultural machinery is employed on farms to-day than was the case a few years ago, and for this reason alone more capital is required.

Capital is always available for industry, but little for farming. The State might well consider methods for providing financial assistance to farmers at a low rate of interest.

Survey of Farm Lands.—A comprehensive survey of Great Britain by a central authority is required to separate the good farming land from the bad and to give an accurate idea of the acreage available for various methods of farming: it would also ensure that good farming land should be reserved for farming where possible and not taken for forestry or building.

Recreation grounds, public parks and golf courses can be reclaimed for agriculture at any time. They form a valuable reserve, but land under trees or building cannot.

Drainage.—Much good land is still lost through defective drainage. The fault may be due to private neglect, but is more often due to causes beyond the farmers' responsibility.

Railways, canals and roads often ruin the existing drainage unless the damage is prevented during constructional work, and often owners of adjoining lands are without any knowledge on the subject.

Education.—Agricultural knowledge might be added with advantage to the curriculum of most schools and often sufficient land might be found to teach the elements of horticulture and cropping. Most pupils would be interested by conducted tours to prosperous farms, research stations, etc.

Agricultural colleges and research stations are essential for spreading farming knowledge and where such centres exist farming prospers, from the fruit farms in Kent to the attested dairy herd farms in Ayrshire. Specialists are required to-day for mechanised farming in all its branches, and more centres are required for training and research work.

Housing.—Through no fault of the farmer or the landlord accommodation for farm hands is often inadequate and many farms are seriously handicapped for this reason.

Farm workers should have adequate accommodation for themselves and for their children. The latter are a most valuable asset in the country.

Unfortunately rural areas are not an asset to County Councils and council houses are seldom available in farming areas.

Electric power and light.—All farms to-day require adequate power and light at a low cost: dairy farms more particularly, but the majority of farms are poorly served in this way.

The West Highlands have their own especial problems and difficulties. Neither the East nor the South nor any Royal Commission can settle these problems. Assistance is required from a body of agricultural experts working in the country itself.

In Australia the virgin country is recovered slowly from forests to cattle and sheep and from cattle and sheep to dairy farming and closer settlement. Over roughly the same period of years the West Highlands has reverted from cattle to sheep and from sheep to afforestation.

The hill grazings are rapidly deteriorating and in addition a serious but unnoticed danger exists: the erosion of the hill soil. Heather formerly grew on the hills right up to the summits, but continuous and unregulated burning has done its work. When no longer protected and drained by heather the soil slips, forms bogs and finally shale alone is left. This is clearly seen on many hills in the West Highlands. On hills taken over by the Forestry Commission this process of erosion has been checked. The fact that drains have been cut down the sides of the hills, the burning stopped and the sheep removed has allowed the heather a new lease of life. Examples of this can be clearly seen to-day. On some hills a clearly defined fence separates the Forestry Commission ground from the deer forests or sheep grazings. On one side of the fence above the young forests heather reaches the hill tops and on the other side the hills are almost bare of heather, the soil is slipping away and bogs are forming. Here bracken appears to be nature's last defence, and it is interesting to note how bracken thrives on the richest faces of the hills.

Originally the glens supplied the wintering for the hill stock, and the head of stock on the hills was regulated by the amount of winter food supplied by the cultivation of the glens. The heather on the hills was kept in good trim by grazing cattle, and young stock thrived on the tender shoots of young heather intermingled with grass. Under long rank heather nothing grows.

Grouse are indigenous to the Highlands and partridges flourished in the glens less than 100 years ago. The fact that grouse are now few and that partridges have entirely disappeared is a danger signal pointing to lack of drainage on the hills and lack of cultivation in the glens.

And what of the wild bees? They have gone and so their honey is lost. The plum and damson trees no longer flourish.

From an agricultural point of view the country is roughly divided into small crofts in the glens and large hill sheep farms. When these sheep farms are no longer profitable the Forestry Commission sometimes takes them over, and the hills are then lost for ever as far as agriculture is concerned. In most cases the crofts do not support their owners who come to spend the

evening of their lives in their own country. The crofts gradually go out of cultivation. What cultivation there is can only be called primitive, and the crofters have little money to help matters.

The old saying, "Look after the glens and the hills will look after themselves," is forgotten. Yet these glens are often remarkably rich and, with a little care and attention, produce excellent crops and vegetables of all kinds and first-class pastures for dairy cows and fat stock.

If this lost country is to be recovered, agricultural centres are essential, also plenty of demonstration crofts and finally a few hill farms well stocked with cattle and wintered with the produce from the rich glens.

Maybe one day the descendants of those sturdy Highlanders who helped to unfurl the Union Jack over half the globe will return and ask us to give an account of our stewardship. Before that day arrives let us make a fresh effort to put our house in order.

Anyone who cares to consult the report of the Royal Commission that sat on the Highlands and Islands in 1884 will see that a serious warning was given then. However, as there was still money in sheep at the time, little attention was paid to that report.

JAMES A. BOWIE, M.A., D.Litt., Principal, School of Economics, Dundee.

What should be the position of agriculture after the war? Economically, I should like to see agriculture transformed into a permanently profitable industry, with a lessening of the risks and hazards that at present beset it, capable of paying wages and giving conditions of employment equally as good as those enjoyed in comparable urban occupations. Socially, I should like to see agriculture made into a self-supporting industry, fostered and encouraged by, but not parasitic on, the State, foremost in applying scientific methods to its problems, and not technical and agricultural science alone, but, by extensive co-operation, reorganising its units, developing marketing and supply arrangements, and, generally, shaking itself free from the weak bargaining position it normally occupies.

To achieve this a duty falls on the State. But it is not, as I see it, the duty of the State simply to rush in to save some panicky pressure group of producers from bankruptcy. There are already far too many branches of industry and agriculture that are no better than old-age pensioners of the State. If the State is to pay the piper, it must also call the tune.

To do so, it must first see agriculture in its proper perspective. It must see agriculture as a producer of commodities needed by

the community; it must determine how many of these commodities it is prepared to import from the Colonies, Dominions and foreign producers, what commodities are most suited for home production, and, of these, which should be produced in greater abundance in accordance with the needs of health and adequate nutrition. From this schedule of commodities the State could then determine the optimum size of the producing unit and the land required, and dovetail its plan with the other needs of an orderly communal life, such as the rehousing of slum-dwellers and the new building programme required to meet arrears. There are a hundred and one other items that would have to be considered in framing this general plan.

The provision of a general framework of reference for agriculture would be the first service that the State can render. Thereafter the State, as representing the general body of consumers, should co-operate with the organisations representing agricultural interests to hammer out the details of a progressive plan of development. In doing so, many valuable lessons can be learnt from similar experiments in other countries, and our agricultural statesmen would be assisted in their work by qualified consultants and a small staff of technical experts. Of the large number of agricultural experiments that have been undertaken in different parts of the world to solve problems not dissimilar to our own, perhaps the most significant is that concerned with the planning of New England—the six states in the north-east of the United States—which covers an area considerably larger than Old England.

On the innumerable matters that would require careful thought—like bulk-buying, grading, marketing, transport, distribution, amenities, education, research, afforestation, smallholdings, etc., etc.—I can make only one comment. We have a Ministry of Food, which is probably the largest trading concern in the world, and which could render immense service to agriculture. It already is the sole importer of the farmers' animal feeding-stuffs, and the controller of practically all he has to sell; it distributes to millions cheap or free milk and controls its distribution and price to ordinary consumers. It is well known that when the price of food is high to the housewife, all the farmer gets of the high price is the blame!

The Ministry of Food could stabilise prices, cut out the glaring wastes and inefficiencies in distribution, improve the public habits in the selection of foods, and thereby see that the scientific farmer gets his due reward for his work. Against the vagaries of wind and weather and unpredictable output, the Ministry could interpose two buffers—both already in operation in war-time: it could extend into peace-time the Joseph plan of storage, and, second,

could use the farm surpluses (as is now done in many American states) as part-payment in kind to the poor—old-age pensioners, those in receipt of public assistance or unemployment relief. Only by such methods can the farmer cease to be the football of other and stronger interests in the food market.

To Scotland, agriculture is relatively more important than to England, and her distance from the markets makes her much more concerned with transport costs. Obviously, the farmer should aim at producing high value in little bulk, and the State and other authorities should provide adequate transport facilities at the lowest possible rate, and with as near an approach as is practicable to the Post Office principle of equalisation. The Highlands are a special problem. I cannot see the Western Highlands becoming a prosperous, pure farming area. I see more hope in afforestation, national parks, the recreation industry, easy and convenient transport, the marking of footpaths, the construction of picnic and camping sites and bathing centres, youth hostels, fishing facilities, with rural industries for the off-season.

So, as I see it, the State should lay down what it wants post-war agriculture to do; it should provide leadership, technical guidance and funds to enable the industry to study its problems; it should undertake as part of its demobilisation plan the public works necessary; and it should encourage by short-term assistance the adaptation of the industry to the new conditions of peace. On the other hand, it should avoid like the plague turning agriculture into a "kept" industry—a sort of permanent "remittance man." If British agriculture has to shrink and the level of cultivation again to creep down the hillsides, it is far better that the readjustment should be an orderly, planned retreat rather than another of these clamorous riots.

SIR ROBERT BROOKE, Bart., D.S.O., M.C., Fearn Lodge, Ross-shire.

We have made many mistakes as a nation: some of them we have repeated after the most terrible warnings and dire experiences. Instance the manner in which we have allowed our agriculture to languish and our rural community to decay. On all sides to-day we hear our folly decried: a country apprehensive of its food supplies affirms that never again will it permit the sacrifice of the countryside on the altar of trade. When victory is ours, shall we then have attained that essential change of outlook through which, setting aside all selfish aims, we may rebuild a mutilated civilisation on a sound Christian foundation?

Assuming the necessary goodwill, we may consider our rural problems, unhampered by old prejudices.

Firstly, rural life must be designed to take its place as the

basis of our national strength and well-being. Before even the fighting services, it must be recognised as our first line of defence. The question "Does it pay?" is inapplicable to agriculture and rural life.

Secondly, the country must be afforded all the advantages of urban conditions but must be shielded against its defects. Community life, facilities for education of the right type, recreation, cheap transport, water supplies, drainage, electricity, first-rate medical services and superlative housing conditions must be made available in addition to the natural advantages which the country provides.

Thirdly, means for attracting the town dweller to take up rural pursuits must be devised. The policy to this end can be summed up in the word "security": assured wages, made possible by assured prices in an assured market. The country dweller should be the debenture holder in the State; large profits will not be expected by those who work and live by the soil; excess profits must be farmed back into the industry for its further development and future stability. The new "outlook" will regard its profits as a token of success; it will not accumulate them to provide a luxury living for the individual.

Fourthly, while the production of food, both stock and crop, will be the main rural occupation, we must also seek to reinstate the vanishing rural trades and small industries and prevent their further concentration in the towns. The village carpenter, blacksmith, plumber, builder, fencer, dyker, drainer are all rapidly becoming a relic of the past; they are honourable trades, they must not be sacrificed to mass production.

More industries ancillary to agriculture should be established: bacon factories, flour and meal mills, creameries, canning factories, potato flour mills, grass-drying plants, lime production, machinery repair shops, and, in suitable areas, forestry, fruit growing and inshore fishing.

To attain these ends drastic changes will be necessary, e.g. :—

Virile government, instead of palliative appeal and compromise, which mark the failings and not the necessary attributes of democracy.

Government control over rural development and efficiency by means of a Lands Corporation or Commission.

Land to be co-operatively or privately owned.

Bad landowners, land speculators and bad farmers must go. All owners and farmers must be compelled to fulfil their obligations; where private enterprise fails, the Corporation should purchase, reconstruct and resell.

We have not yet witnessed any form of State ownership which would encourage the idea that the new agricultural system should

be run on these lines. It may be that the future will see the nationalisation of public transport, banks, coal mines, etc.: if so, democracy must evince a greater capacity for the selection of the right men for managerial responsibility. A nationalised agriculture would be a very risky and unnecessary experiment, and one which the country would be ill-advised to attempt until the State had shown some marked ability for industrial management in other and less vital spheres.

If rural life is made attractive, we must arrange to accommodate a greatly increased rural population. Acres are limited, but much reclamation can be done. There is nothing inherently wrong with the small farm as an economic unit, provided markets, prices, and occupants are right. Division of the country into a few large farms only might be sound financially, but it would be ruinous nationally.

Large farms of from 1000 to 4000 acres should form the centre for a district consisting of a large number of smaller units of varying size. The central farm must exercise control over all adjacent holdings, and would comprise advisory staffs, experimental work, pedigree stock breeding, machine hire section, technical education, veterinary branch, milk recording, tradesmen, etc. It would also form the community centre and village with its church, shops, school, library, reading rooms, dance hall, cinema, garage, etc. Farm workers (except stockmen) for the larger farms in the district would be housed in the village, and it would be the site of the ancillary industries. The smaller farms would be worked on a family basis, most of the heavy field work being done by contract by the central farm. As a centre for the marketing of produce and the purchase and distribution of farm requisites, the central farm would provide in all respects the advantages of mass production, mechanisation and central control without the drawbacks.

Primary education in the country should be framed to lead to rural occupations; more latitude should be given to teachers in selecting the few special pupils for the universities and professions. The average country pupil should pass on to the local technical school. Opportunity must be given for apt pupils to attain responsibility in early life.

There must be no wage incentive to leave agriculture; wages must be as high as in other industries; employment must be assured, and there must be no such thing as unemployment pay, except in return for productive work. .

The necessary constructional work for the proposed farm district organisation will give employment to demobilised men for many years; plans should be worked out now.

Existing land legislation is too involved and antiquated for

application to any modern system of reconstruction; it should be abolished and a new and simplified code evolved.

Any general policy for rural life must be subject to modification to suit local conditions. For example, a variation is necessary for the crofting districts in the Highlands of Scotland, and the reinstatement of hill sheep farming will involve some very special treatment.

The general principle of finance must be large credits to enable rural life to establish itself on an economic basis; direct subsidies are a product of defeatism and contribute to delay in any long-term policy.

JOSEPH F. DUNCAN, Secretary, Scottish Farm Servants' Branch of the Transport and General Workers' Union.

The position of agriculture in the economic and social structure of Great Britain after the war will largely depend on what steps are taken, internationally, to give effect to the 4th and 5th principles in the Atlantic Charter :—

> They will endeavour, with due respect for their existing obligations, to further the enjoyment by all States, great or small, victor or vanquished, of access, on equal terms, to the trade and to the raw materials of the world which are needed for their economic prosperity.
>
> They desire to bring about the fullest collaboration between all nations in the economic field, with the object of securing for all improved labour standards, economic advancement, and social security.

These principles are necessarily general in their terms, and everything will depend upon the actual measures adopted to give effect to them. But, if there is to be access on equal terms to the trade of the world and the fullest collaboration between all nations in the economic field, the trade in food products will be one of the biggest factors to be taken into account. If these principles are to be given effective force there will have to be a reversal of the policies of high protection, subsidised exports and economic enclaves, pursued by most countries during the past decade. It is difficult to see how policies, of which the Ottawa Agreement is an example, could be brought into conformity with these principles.

The decisions which will have to be made on international trade are matters of high national policy, and many factors, industrial, manufacturing, trading, shipping and financial, will be involved. They cannot be made with a single eye to the position of agriculture, but when they are made they will decide the extent to which, and the directions in which, agriculture is to be developed

in this country. Those who are confident that we shall see an extensive development of agriculture in this country after the war are registering, once again, the triumph of hope over experience.

When the general trade policy of this country has been decided we shall then have to decide what the position of agriculture is to be within that policy. We shall have to decide what we want agriculture to do, and what price we are to pay for doing it. Obviously, if we want agriculture to occupy a defined position we have got to plan the general lines of development. We have been doing that more or less for the past three decades, but it has been by a series of haphazard measures, and no effort has been made to work out any comprehensive ground plan. Sometimes we have had social objectives in view, sometimes economic ends, but more often we have merely resorted to political makeshifts. If we are to follow any comprehensive plan we shall have to decide what we want agriculture to do. We can decide that the business of agriculture is to produce those food products which we find it necessary or desirable to produce in this country as efficiently as we can, or we can decide that we want to maintain as large a population as we can afford to employ in agriculture. The first policy is an economic one and the test of it must be its efficiency; the second policy is a social one and many tests may be applied to it, but not the economic one.

For those engaged in agriculture the safest policy is the first one. If it is desired to maintain a larger rural population there is no reason why agriculture should have to shoulder the burden. Under modern conditions of power distribution and transport there is no reason why a larger rural population should not be maintained by a dispersal of certain industries of the lighter type which would give the workers in those industries any advantages there are in rural life, and enable them to rear their families in rural communities. There would be mutual advantages to those engaged in agriculture and in industry, and the cost to the community would be much less. The forlorn hope we have been pursuing for the last generation of increasing rural population by setting up uneconomic small-holdings could then be given up.

If our policy is to make the industry efficient enough to stand on its own feet then we shall have to provide the means to enable it to function properly. Certain recent trends indicate what is needed. Private landowners, with few exceptions, are no longer providing the capital equipment necessary. The State is having to come to the rescue with various subsidies. If we are to follow any comprehensive plan for agriculture we must have continuity of policy, and there must be adequate provision of capital for the land. The State alone can ensure continuity of policy and is the only source from which the necessary capital can be found. The

logic of the situation is national ownership of the land. Then in farming we can see a definite trend towards multiple farming. The typical farm in Scotland is not big enough to carry the cost of efficient management. So the efficient farmer, since he cannot, as a rule, extend his farm, takes on other farms. This development is likely to extend because of the growing mechanisation, which will necessitate more capital, and a larger area for its economic use. The organisation of marketing with more stable prices will lead to more concentration on production and less on following fluctuating markets which will favour the larger unit of management. Adequate farming capital will be necessary to enable the fullest use to be made of scientific and mechanical developments, and this again will strengthen the trend towards larger units of management. Working in the same direction is the movement towards bringing the wages of farm workers nearer to those of industrial workers. This will necessarily tend towards economy in labour, which will place farmers on the smaller farms at a disadvantage.

Any State policy for agriculture must take account of the economic forces at work within the industry and, if they are tending towards greater efficiency, should work along the lines the industry is working. It is only thus that agriculture can be helped to stand on its own feet.

MRS EVA GOOCH, President, Scottish Women's Rural Institutes.

The position of agriculture in the economic and social structure of Great Britain after victory in the war should be a prominent one, and the general policy of the State should be to realise that we must, as far as possible, be self-supporting, and realise that insufficient guidance and help have been given in the past to agricultural and rural life. Much has been done in many ways to foster and promote certain sides of agricultural life, but one feels that there has not been a definite co-ordinating policy running through the scheme.

It is very difficult to write on these questions without first dwelling on the people who make the whole agricultural life in Great Britain a living or a dead industry, that is, the farmers and the farm workers.

It will be very difficult to bring back the younger men and women to work on the land after the war, and much will have to be done to make this work more attractive than it has been in the past. Surely every nerve will be strained to do this and to try to make these men and women realise that it is not a disgrace to till the land, and that every ounce of brains and ability is required to make agriculture the success it ought to be.

The desire to get to the towns and to share in the social life which abounds in cities might be combated by settlements with facilities for community life, with facilities for travelling cinemas, libraries, etc., but this cannot be achieved unless all departments are prepared to work together and to find out the needs of the rural population. There must be more co-operation between all public bodies than there has been in the past, for all must be prepared to work together for the life of the nation so that a perfect scheme can be achieved.

In evolving any scheme, certain definite points require to be considered, such as:—

Housing.—This is a most vital question, which is being very seriously considered by everyone just now.

Education.—People in most professions and trades require and receive definite instruction before undertaking work: why should there exist in agriculture practically no guarantee that those who are going to till the land know anything at all about it? People who are going to take up agriculture should be taught the proper care of animals; the question of drainage, because so much land is wasted by not being properly drained; the nourishment of the land, and the damage caused by weeds, because not everyone realises that, though land covered with thistles and other weeds may not in itself be waste land, the seeds from these weeds are blowing on to good and profitable agricultural land and rendering it useless.

Wages.—The question of wages will have to be considered, in order to try to make it possible for farm workers to receive a wage corresponding to that earned in other industries.

One of the chief problems confronting the revival of agricultural life in Scotland is the question of transport. If rural life is to be made more attractive, there must be improvement in transport services so that it is easier for people in the country to get about. The question of freight is also a most important one in Scotland as the high freights that exist in the Islands and remote places are strangling agriculture.

WILLIAM GRAHAM, President, National Farmers' Union and Chamber of Agriculture of Scotland.

To attempt to formulate any detailed or settled policy for agriculture in the post-war period would be futile at this juncture—nevertheless the problem of reconstruction calls for careful study of the political, economic and social repercussions of the war if a policy is to be evolved which can be applied the moment freedom is assured.

The position of agriculture in the national structure will depend on certain factors difficult to estimate in the present transitional

period, but this does not preclude a survey of certain essentials upon which any policy must be based.

Primarily there must be recognition of the national importance of the industry. It will not be sufficient to continue agriculture on a care and maintenance basis—there must be appreciation of the potential market which a thriving countryside offers, the employment to be created, the vigorous manhood of which the country is the reservoir, and that the life and industry of the majority of our towns and villages are dependent on the land and those who live by it. If, therefore, we may assume that the lessons of past neglect will not be forgotten and the advantages which agriculture can contribute to the national life are recognised—what action is necessary to attain and maintain a proper status?

A background of informed public opinion will be required to enable effective legislative action—to this end education of our urban population is essential, in order that they may view the case in its true perspective and overcome the bias against agriculture which has arisen from pre-war world trading conditions and the need for cheap food.

Rural problems of housing, amenity, transport, education and economy are awaiting solution, and can only be solved with the assistance of legislation—hence the need for an informed electorate.

A fair price policy must be established to enable agriculture to cope with the conditions of overseas production, while at the same time taking the maximum advantage of world prices in the national interest.

Agriculturists cannot expect to be relieved of the burdens which beset them unless they do everything in their power to help themselves. Voluntary action in formulating schemes to meet the national and individual requirements would necessarily be slow, and such delay in present circumstances would be fatal.

The revolution which had begun as a result of the precarious pre-war era must be speeded up if agriculture is to survive, and, much as the independent spirit of Scotland may resent it, there seems to be no alternative to some form of "direction" in order to attain the end in view.

Government aid will not be forthcoming unless that aid can be directed to the national advantage. That does not preclude those engaged in agriculture having their due say in the action to be taken—but they must come to early agreement on the line they consider necessary if they are to mould the policy and secure the most practical plan for their own and the country's good.

The form of administrative machinery to be adopted is of paramount importance, and attention will first require to be given to the direction of home production and the organised marketing

of that production, and, secondly, to the control of imports in relation to home supplies and the needs of the nation.

Overseas trade will, as in the past, have a major bearing on policy, but changes in the field of world economics and industry are presently beyond estimation, at least by the layman. This will necessitate that the administrative machinery is such as to allow for evolution as reconstruction progresses.

Consideration should be given to the adaptation of the war emergency administration for post-war purposes, even to the retention of the Ministry of Food. This may be necessary to clear up the immediate aftermath of war, but to perpetuate such an elaborate organisation would seem to be out of the question.

For the direction of home production the obvious administrative machinery would appear to be some form of the present agricultural executive committees, working through trained executive officers and under the jurisdiction of a National Production and Marketing Commission which would be responsible to the Minister of Agriculture and the Secretary of State for Scotland. The Commission would be responsible for the organised marketing of home production through the medium of existing Producers' Marketing Boards and Commissions or through Boards to be established for those products not yet provided for. To these Boards would fall the work of advising the National Commission and administering the price policy determined by it.

Having established orderly selling organisation, producers would expect to be able to buy their requirements in an orderly way, and the amalgamation and development of existing agricultural co-operative concerns would appear to meet this purpose.

Import control would be the concern of an Import Board under the Board of Trade, but the closest collaboration and co-operation would be necessary between the Import Board and the National Commission under direction of the respective Ministers.

If some such organisation were adopted to administer policy it would provide the elasticity required and could, at the same time, secure the liaison necessary between the Industry, Government Departments and the Ministries concerned.

The objective must be to take the fullest advantage of our home agricultural resources. Every acre of land, arable and pastoral, must be utilised to the fullest extent, taking care to preserve the balance between these two to conserve fertility. Labour conditions and wages must be such as will secure a growing and contented rural population, while land and estate management must be efficient and progressive.

Powers given to enforce efficiency need not be looked upon as dictatorial if due regard is had to the circumstances of the individual and steps taken to remove difficulties and offer assist-

ance where necessary. Above all there must be uniformity and equity in administration.

By such an orderly revolution as could be organised on the lines indicated agriculture would be enabled to contribute its full quota to the post-war social and economic structure of Great Britain.

Scotland need have few problems of her own in such a structure since she would expect equitable treatment in the scheme of things, and such difficulties as distance from consuming centres and sources of supply are matters of degree which should receive consideration in relation to the country as a whole.

Many other problems—food distribution for instance—though not strictly agricultural, must fall within the orbit of a wider revolution which will affect all and sundry and in which agriculturists must play their appropriate part.

SIR ROBERT GREIG, M.C., LL.D.

To discuss the position of agriculture in the economic and social structure of Great Britain after the war is an essay in speculation, for it depends on to what extent the Atlantic Charter is put into operation. If security from war is assured, then the "safety first" motive for an extended and intensified agriculture is gone, and if protective tariffs are lowered and subsidies diminished by international agreement, then the future of British agriculture is dark indeed, for, with the exception of milk, in nothing that he produces can the farmer compete with foreign and Dominion imports at world prices. The alternatives would then appear to be, let agriculture decline to the verge of extinction or subsidise it. For various reasons it is probable that agriculture will be maintained and therefore it will be subsidised.

In that case, a statesman faced with the necessity of obtaining large annual sums from the taxpayer and consumer—90 per cent. urban—will put to himself the question, "Is the land to be farmed for the benefit of the farmers, or for the benefit of the nation, i.e., the people as a whole?" As the people will be paying, there can be only one answer. The second question then arises, "What policy should be adopted to make the best use of the land in view of the needs of the people?" Again there is only one answer. The priority needs of the people are for milk and fresh vegetables which Britain can produce in abundance. Arising out of these two questions the third propounds itself. "How can milk and vegetable production be increased by 50 to 100 per cent. and the milk sold at a price the consumer can afford?" According to Lord Reith the planning of agriculture after the war will be a definite part of national reconstruction.

The answer to the last question would thus appear to be the planning of the milk production. But those responsible for reconstruction will ponder over the fact that with, on the whole, a fertile soil, a favourable climate and the best market in the world at their doors, the farmers are unable to produce at world prices. It will then be discovered that, not the soil, the climate, nor rapacious landlords have defeated the farmer, but science. Science has outmoded the structure in which the farmer is confined as the power loom outmoded the hand loom. Over a hundred years everything has changed in farming except the farms and the fields. Over the country there are able and skilful farmers who are placed in circumstances where their technique, their farming and business methods are given full play to great advantage. But a far larger majority, who may be equally skilful, are in farms too small or too large, with fields the wrong size and shape for mechanised operations, with out-of-date buildings incapable of modernisation, possibly land in need of drainage and the occupier in need of capital. In the eighteenth and nineteenth centuries the wealthy landlords reconstructed their estates according to the science of the day, to the great benefit of themselves and the country. They cannot do that now. Only the Government that pays no death duties, is rich enough, lives long enough and is powerful enough to reconstruct our agriculture. But that involves the public ownership of the land. However reluctantly it may have to be admitted, there seems to be no escape from the dilemma, i.e., that British agriculture cannot hope to be a national asset and not a liability unless it is replanned and reconstructed, and only the State, or Commissions or Corporations working with the State, can reconstruct it. (I do not suggest farming from Whitehall or St Andrew's House.)

I am asked if any modifications of this policy, or any special developments are desirable for Scotland. I do not think so. If a long-term policy for agriculture is good for England and Wales it should be good for Scotland. Hill sheep farming, which is mainly a Scottish problem, might require special consideration. Moreover, certain discriminations might be admitted. Scotland might be allowed to demand a higher standard of farming as it has been allowed to require it in the past. I am aware that I have dealt with the future of British agriculture in the most general fashion. Mixed farming, stock breeding and feeding, cereal growing and beet growing come in for planning too and the social side cannot be ignored. The subject teems with difficulties and complexities, but the problems cannot be settled by a policy of *laissez-faire*.

These speculations may be irrelevant during the period when hungry Europe must be fed. They may be equally irrelevant if

an international agricultural policy is adopted involving great sacrifices of our agriculture for the sake of permanent peace.

Obviously much is left out, much is controversial, and what there is, invites criticism and suggests innumerable questions, beginning, "but if . . . then what?"—but this is all the space the Editor allows me.

PROFESSOR JAMES HENDRICK, Aberdeen University.

Agriculture is the greatest fundamental producer of wealth and produces it without using up the raw materials from which it is produced. Coal and oil and iron ore when used cannot be replaced, but the raw materials from which agricultural wealth is produced are sunshine, air, water and soil. The first three are constantly being renewed and are likely to continue, as we have known them in the past, for any time in which we are likely to be interested. The fourth, the soil, can be wasted and its fertility exhausted, but fertility can be maintained indefinitely even under intensive cropping when the soil is treated with knowledge and respect.

We cannot continue to spend 13 million pounds a day on destructive and unproductive industry without becoming poorer. The whole world will be poorer, and, in spite of all that science can do for us, we shall not be able either to export or to import as we were able to before the war. We shall not be able to pay for agricultural imports from abroad as we could before the war, and we shall have to depend on home agriculture to produce our food to a much greater extent than we were accustomed to in pre-war days. It will therefore be necessary for the State, which means all of us, to continue after the war to promote and foster agriculture and see that the maximum use is made of our soil, that great producer of wealth.

The State will have to maintain such control of prices and imports as will enable home agriculture to continue to be profitable and able to pay the wages necessary to maintain a sufficient staff of skilled workers on the land. This will imply that the State will continue to control agriculture to a certain extent, as it is doing at present. It will be entitled to insist that agriculture is carried on efficiently, and it will continue, and probably improve the machinery for getting rid of the slack and inefficient farmer. The inefficient farmer cannot be allowed to set the standard of prices, as he would if prices had to be such as would make the inefficient prosperous.

The more we improve agricultural machinery and appliances and the more we increase scientific knowledge of farming, the more we put the small man, the smallholder, out of date. Agriculture in this respect is like other industries, though it is

surrounded by a good deal of sentiment and romance, and cluttered up with a great deal of legend and old history. If it is to contribute its share to the safety and advance of the country it will have, like the handloom weaver and the village blacksmith, to bid farewell to a romantic past and build up an efficient future which will in time, no doubt, build up a new romance and tradition.

During the war we are finding it necessary to use more and bigger machines on the land. Such mechanisation of farming is not going to cease at the end of the war; it will continue and increase. The more it increases, the larger the economical agricultural unit becomes and the more the agricultural labourer must become a mechanic, entitled to earn wages such as are paid to mechanics in other industries. Like the smallholder, the farmer of an ordinary holding of 100 to 200 acres cannot give economic employment to a full equipment of modern machinery. Not only so, but the ordinary small farmer cannot be an expert either in agricultural science or in business management. We try to get over this difficulty by providing a staff of expert advisory officers and economists to help the farmer. But this is only a crude and partially successful attempt to solve the problem. The farmers who make use of such help and advice are, generally speaking, the most enterprising and efficient men, but there is an inert mass of ordinary farmers who are little moved. In my opinion, therefore, the general policy of the State in relation to agriculture and rural life should be to promote conditions favourable to the creation of large and efficient agricultural units, not smallholdings. This will require a courageous statesman prepared to look boldly at things for himself, unmoved by sentiment and tradition. The Russians are now our friends and allies and we may have something to learn from their experience in changing from a country of peasant holdings to one of huge collectivist farms. This does not imply that we should adopt either their political or agricultural system, but they have made a great agricultural experiment from which we may have something to learn, though we are not likely to carry out so rapidly such a revolutionary change in the whole system of agriculture.

A great defect in our present system is that it provides no career in farming for the young man of ambition and capacity but without capital. He must become a labourer and may, with difficulty, rise to be a smallholder or small farmer, although his capacity may fit him to be a manager or director of a big concern. He, therefore, as a rule, goes into some other industry or profession, and agriculture is drained of some of its best brains. On the other hand, many of those who are farmers on a moderate, or even on a large scale, are only fitted to be assistants working

under the direction of men of greater knowledge and capacity. A system of large units would help to cure this, and the young man of ability would rise to be a manager or director.

It would require more space than I have to discuss the question of landlord and tenant. If the State is entitled in the national interest to see that the farmer is efficient, it is also entitled to deal with landlords, and secure that they do not interfere with the full use of the land of the country for productive purposes. As a general policy it might be necessary to do away with our present landlord and tenant system, and for the State to acquire the land of the country. Efficient farming in large units would not do away with sport, but sport should not be allowed to take first place and interfere with full production of essential raw materials from the land.

A landlord might, of course, turn his estate into one large farm with himself, if he has the knowledge and capacity, as the managing proprietor of the business and a staff of assistant managers of different departments under him. Such a business would be managed from an office where complete accounts and records would be kept as in any other well-managed business. A large-scale farm might, of course, be run as a limited company with the proprietor as chairman or managing director. The essential thing is, it would have to be run efficiently to justify its existence. The successful farming of the future will be large-scale farming carried out with efficient business management and with all the aid scientific knowledge can give it.

MAJOR JAMES KEITH of Pitmedden.

As a landowner and farmer I am likely to treat the subject with bias and give rein to what I strongly hold—that agriculture is the basis and main prop of civilised life, and, until recently, has been the main fountain of a healthy and strong population. I will assume that the nation wishes this to continue.

In the past fifty years the intellectual and physical drain on the rural population has been very severe. It has gone on steadily, but during the past twenty-five years it has been very much intensified for various reasons. The intellectual drain is easily seen in the fact that very large numbers of the brightest of the country people have seized the chances given by education to leave the country for more attractive jobs, and physically the drain has been equally great through the recruitment of men for all kinds of jobs requiring good physique and character.

There has been no corresponding flow from the cities to the country, and I think it must be admitted that a fairly steady deterioration has gone on in the country population, although, from

better living conditions, there has been a steady improvement in physique, if not in character, of the city dwellers.

The problem is how to restore the balance of advantage between town and country in such a way as to attract the best elements of the country people to remain there. The solution is partly economic and political and partly social. Before a healthy countryside can be built up and maintained, the business of farming, which is the fundamental prop of the whole rural social system, must be put on a sound footing. This is the job of the Government. There is a tendency on the part of the city people to lay the blame for all troubles on the farmer. No doubt there are great numbers of backward and unintelligent farmers, as there are in other lines of life, but, on the whole, the farmers are quite as good as anyone has the right to expect after the way they have been treated in the past sixty years.

In regard to major matters of price policy, the farmer is completely helpless. He can never produce wheat at prices to compete with those at which the world surpluses may be dumped here, nor sugar as cheap as coloured labour can grow it in Java, nor beef as cheap as that from the Argentine; but a stable and healthy rural population can be built up and maintained on a reasonable basis such as was reached before the war by the legislation affecting wheat, sugar and beef, and by the various Marketing Boards, although some extension is necessary.

I am aware that these are called subsidies to farmers, doles to landlords or labourers or tampering with the people's food, according to personal inclination or political bias, but the more sensible way to look at it is as an insurance premium to maintain food prices at reasonable levels and provide a vast, secure, internal market for manufacturers. Practically all money paid for home-grown food is respent in the country against anything from 15 to 50 per cent. of the money paid for imported goods.

The social side of the country needs a deal of attention, especially in the matter of housing and water supply. The percentage of farm, croft and cottar houses which are still without efficient water supply and drainage is deplorable, and, unless active steps are taken to remedy this, a further deterioration in the whole rural social structure is inevitable. For example, in one parish in Aberdeenshire out of 329 houses only 160 have sinks, 83 W.C.'s, 73 bathrooms, and no fewer than 176 have no scullery and all the washing up, etc., has to be done in the kitchen, while in the case of 246, their sole sanitary convenience is a privy; there is no public service of electricity anywhere. Very few neighbouring parishes are better off, and a great many are much worse. Even if wages are brought up to and can be kept at a satisfactory level, unless housing and other amenities are improved, good class

workmen and their wives will not remain on the farms, but will migrate to towns where they can obtain reasonable comfort. The horrid state of many farm and croft houses is reflected in the great numbers of farms and crofts which are unable to find separate tenants and are held in multiple.

I think that the State should adopt a long-range policy of fair prices and insist on a high standard of farm management. They might also embark on a definite reconditioning of farms through a system of loans at reasonable interest. If money can be had to blow away in shells at 2½ per cent., it would not be unreasonable to suggest a similar or even less rate for reconstructing the country for production work.

I am aware that many estates are in a difficult position through inefficient management over a long period, and latterly taxation has made their situation impossible. I think the only solution is for the State to take them over if the existing owners are unable to handle them. Possibly economists will not agree with me, but the State can do many things profitably because of indirect return which the private owner does not benefit by. For instance, by reclamation of land the national income is increased by the value of the produce distributed through many channels, but the actual reclaimer may fail to make a profit for himself.

Regarding special Scottish conditions, I would just like to note that rural parish life is now poorer because of doing away with School Boards and Parish Councils, which gave people a direct interest in their own affairs. The influence of the individual is now so small that no one seems to take much interest. We just expect the Government or someone else to do for us. Some parishes have retained a Parish Committee which serves a very useful purpose and might be copied and given some official recognition.

Among other things which make for the poverty of social life in rural parishes in Scotland is the practice of Education Authorities of permitting carpet-bag teachers who come on Monday morning and go on Friday night. Teachers have a unique place through being in touch with all the families, and anything they do has the merit of detachment from commercial affairs.

The recent "Standstill" Order for farm workers is a most interesting experiment which may have very far-reaching effects, not specially contemplated by the authors, if it breaks the serious habit of being always on the move, and brings a large number of people, who, through their migratory customs, are apt to remain a class apart, more into the community life; it would thus do for the men what the Women's Rural Institute has, to a large extent, done for the women.

THE EARL OF LEVEN AND MELVILLE, K.T.

Discussion on farming after the war is difficult until some prospect may be had of the post-war position generally, and in this country in particular. But it is pretty safe to say that most farmers to-day dread a repetition of the agricultural policy pursued in 1921 and throughout the years afterwards, and have not much faith that a town-dwelling population will for long resist the desire for cheap food without too much regard to its place of origin.

Two aspects of the agricultural industry in the North of Scotland appear to me, however, urgently to need solution. The first is the position of the farmer who farms at great distance from his markets and purchasing centre. On this point I write with the full force of having for years watched the farmers in the northern counties of Scotland trying to grind a profit out of their business in spite of having almost always to pay more for their farming necessaries, and to receive less for their produce than their competitors in the south situated nearer to their markets. This brings one back always to the question of a flat transport rate by rail, road or boat for agricultural produce and for the necessaries for the farm. A postal parcel from London to Wick costs no more than a like parcel sent from London to Hatfield or St Albans. Shall we ever arrive at the time when farm produce will be treated in the same way? Until we do, the North of Scotland farmer will continue the unequal struggle of having to produce his goods at a lower cost than his southern competitor if he is to make a fair profit in return for his labours.

The second point is the need to treat differently varied types of farmers on different types of soil, and to cease to regard agriculture as a single industry without any regard to local conditions. Can anybody really defend the principle of paying to a farmer a subsidy of £2 per acre for ploughing up old grass, whether his land is capable of growing, say, eight quarters to the acre or only four quarters? The cost in each case is relatively the same, but the yield in the second case only half that of the first. Closely allied to this point is the case of the farmer who knows from long experience that, whereas his farm can produce only poor corn crops, it can and does produce some of the finest stock, whether cattle or sheep, in the whole country. The position of such a farmer since the outbreak of war has been pathetic. The form of farming which normally he may follow most profitably has not been wanted, since the Government needs cereal crops and not beef or mutton, with the result that he has been actively discouraged from following the farming policy which he has proved to be sound, and has been requested to follow, in a patriotic spirit, a policy which he knows to be uneconomic in his case.

Normally he grows crops to produce manure and to feed the stock from which his profit, if any, is derived; he sells practically no corn off the farm. To such a man it paid well when the oats and straw which he fed to his stock were cheap, and the price was made up by a cash subsidy; whereas the rise in the price value of his crops simply raised his costs of feeding his stock, without a corresponding rise in the selling value of his store cattle or sheep, and the cash subsidy disappeared. So present-day conditions may mean good profits for the farmer of good corn-producing land, and misery for the breeder of stock who grows only medium or poor corn crops. Yet we have, I believe, been officially told that the second type of farmer cannot be better treated, because, if he were, the farmer of the first type would make too much money. My answer is that, in order to treat all farmers fairly, one must classify all farms and then treat them fairly, each in its own category of farm. It is not perhaps for me to enter into details here as to the number or variety of categories necessary; but I see no other way in which fair treatment can be meted out to all the different types of farms and farmers.

Critics may say of my description of the stock-breeding farmer that prices of cattle and sheep have latterly risen sharply. This is perfectly true, though there may have been plenty of room, in view of the increased cost of production, for that rise. But cattle prices rose owing to the embargo on Irish cattle, and, at the time of writing this, the prices are already tending to sag owing to the prospect of Irish store cattle being shortly reintroduced into this country. Similarly, sheep prices have risen also, owing to scarcity of supplies, but it has to be remembered that many sheep farmers have this year only half their usual numbers of sheep to sell owing to losses last winter and spring. The individual breeder of cattle and sheep is often in a small way of business, but there are many of his type, and in the aggregate they produce very large numbers of store stock of excellent quality. If such men are driven out of business by a continuation of the treatment which they have received during these war years, their disappearance may cause little public stir at the time. The arable farmers may not see in time that the producer of store stock, which they must have for their feeding yards, is disappearing. The country, then, will discover too late that some of its best types of agricultural products have ceased, and that the place which knew that type of producer knows him no more. And so I come back to the point that, if you are to treat all farmers fairly, the first necessity is a complete classification of farms, and the evolution of a policy to provide fair treatment for each farm according to its category, provided that it is well farmed. And I believe that, with reasonable help from the Department of Agriculture for Scotland, no

better bodies could be found with the necessary local knowledge to make this classification fairly than the present Agricultural Executive Committees.

MAITLAND MACKIE, North Ythsie, Aberdeenshire.

If, as suggested by the Prime Minister, we are to have a Coalition Government for a few years after the war, then any policy with any hope of acceptance must be one that will work inside the framework of such a coalition.

Firstly, then, we must decide what we are to do for the workers on the land. The policy may well be :—

(i) That hours and wages should be fixed by a Wages Board as at present.

(ii) Good houses up to the standard of the city council houses should be provided. All rural houses must have a bathroom and hot and cold water circulation.

If there is to be a forward movement then many more houses will be required. There will be houses on the farms for the stockmen and new houses in nearby villages for the other farm workers. Opportunity is here to add character to the countryside by the employment of planning experts in all counties so that the new houses are planned and placed to add to the beauties and amenities of the district.

A too nationalistic policy will probably not be in keeping with the ideals of the future. If we are to take our share of the world's goods it does seem that the things to import are those which require least labour spent on them. This would leave the more processed foods to the agriculturists in the country.

It might profit farmers more to let cereals such as oats, barley and wheat take the cold blast of foreign competition, and reserve for themselves the more processed foods such as beef, milk, mutton, vegetables, eggs and bacon. Thus they would take advantage of the cheaply produced foods from abroad to produce the fresh, health-giving foods at home.

Previous notice of this policy would have to be given so that the farmer who has been busy producing cereals could adapt his farm to the changed policy. Some farmers, remembering the last slump, which included livestock, will certainly say, "If that is to be the policy then down goes my farm to grass." Even with the now greater knowledge of grass management stock must still follow the plough. And the dairy cow, the beef bullock and sheep will still require the short ley.

Whether the sheltering of the new industries to be developed be done by tariffs or subsidies should be a matter of comparative indifference to the farmers.

I know that many farmers in the East of Scotland will ask—Why leave out cereal growing? Well, in the main, cereals are not a finished product. They are the raw material of the beef, milk, bacon and egg producers, and the dearer the raw material the more difficult the home production of these essentially fresh foods becomes.

When the National Farmers' Union and the Chamber of Agriculture take this problem in hand they should bear in mind how few of the 70,000 farmers in Scotland sell any grain at all. Forty-six per cent. of these farmers have holdings of between 5 and 50 acres, and the next largest group, 22 per cent., have holdings of 1-5 acres. Only 3·2 per cent. farm over 300 acres.

This 3·2 per cent. forms the most vocal part of the National Farmers' Union. It is natural, therefore, that the Union should appear at the present unwilling to favour such radical changes in agricultural economy as have been suggested. But when the leaders of the Union come to consider these changes they should bear in mind that, even now, many large farms do process their cereals into animal products, and that the livestock industry is worth seven times as much money to the farmer as the cereal industry.

The proper balance between town and country cannot be held by farming alone, and everything possible should be done to encourage rural industries. Milling need not be allowed to decay through the importing of larger quantities of wheat and oats. We could prohibit the importing of the processed goods, pearl barley, oatmeal and flour.

The policy of giving wages and houses that reach the standard of those of the city dwellers could, of course, mean high prices. But this is not necessarily so.

There are examples in the past to stimulate us to find other ways of cutting costs. Twenty years after the introduction of wild white clover we were paying double the money wages, and oats were at the same price or less. The introduction of efficient bacon factories with a throughput of 1,000 pigs a week would mean much more money to the pig farmer. The coming of the tractor meant that two to three times as much work could be done per man. It is now estimated that milk from abortion-free herds could be sold at ½d. per pint less. The possibilities of grass silage seem considerable.

Given free enterprise, high wages may stimulate the farmer to high endeavour. Given a Government willing to support these processed foods—support which should not be beyond its financial ability—then the farmer can turn with confidence to his job which in its nature will require an increased agricultural community. The potentiality is great both for the farmer and the countryside.

FLORA, MRS MACLEOD of MACLEOD.

The contributors to your *Journal* have been asked to answer a very large question very briefly. This necessitates the making of assertions insufficiently qualified and insufficiently supported by argument. My "assertions" are limited to the Highlands and Islands which present different problems from the rest of Scotland.

All your contributors must surely agree that the position of agriculture in the economic and social life of the nation is vitally important, and that the State has an essential contribution to make. Believing that in planning the new post-war world no change, however revolutionary, is barred I begin with the fundamental question of land tenure.

There are three main systems :—

(1) State ownership.

(2) Landlord ownership.

(3) Individual ownership.

State ownership.—I submit that this is the wrong solution. The Government department exercising proprietary rights does so from an office remote from land and tenants. The local factors, however conscientious, have no power to make decisions. All but the most trivial questions have to be referred to Edinburgh. Edinburgh itself must often refer to the Treasury in London. The result of not being able to take responsibility on the spot is delay, often long delay, and this produces dissatisfaction and a general sense of frustration. It is the fault of the system not of individuals operating it.

Landlord ownership.—Broadly speaking this has been the prevailing system for many hundreds of years, and if it had not worked well we can safely say that it would have been put an end to long ago. An absentee landlord is an evil; a bad landlord is an evil. But the large majority of proprietors administer their estates with high conscientiousness; they love their land and make sacrifices for it; they are able to make decisions on the spot and to act upon them; their tenants are their friends, and there is co-operation and respect between both parties.

It is the case that most crofters prefer the landlord they know to the far-away Government department.

But conditions are changing fast. Very heavy taxation, where it has not forced the landlord to sell outright, has limited his power to improve. "The old order changeth yielding place to new, and God fulfils Himself in many ways."

Individual ownership.—This I believe to be the right system. There is a thrill and pride in ownership which nothing else can give. I quote from the Report of the Highlands and Islands

Committee. "We view with disquietude the absence of a spirit of enterprise and the slackening of moral fibre in some districts, and think that the inherent interest of land ownership is the most likely means of maintaining the population on the land, of creating a spirit of enterprise and independence and of raising the standard of cultivation."

It has been said that the crofter prefers his present privileged status which gives him security of tenure, the right to appeal to the Land Court to have his rent fixed and, if necessary, altered, and the right to compensation fixed by the Land Court if he surrenders his croft; and it is pointed out that when the late Lord Leverhulme died in 1925 and the holdings in Lewis were offered as a gift the offer was refused. I think when that argument is put forward as conclusive it is forgotten that, before the passing of the Local Government Act in 1929, rates in the Islands varied between 20/- and 30/- in the £, and the crofter, by accepting, would have made himself responsible for the payment of both owner's and occupier's rates. The situation is now revolutionised by the derating of agricultural land and the rates are now little more than nominal.

What part is the Department of Agriculture to play? A vital one. It must supply leadership. It is worse than useless to create a population of smallholders and not provide the conditions necessary for success. The smallholder cannot make these conditions for himself. An organisation must exist to do him service, to ascertain his needs, to co-ordinate and supply them. For example:—The Islands breed stock on a large scale. It has been estimated that Skye alone exports annually nearly £100,000 worth of beasts and wool. Marketing conditions are chaotic. Each little township makes its own arrangements, arranges its own transport, and sends its own shepherds to the market selected. The sheep have lost condition on a trying journey and this is reflected in the price. Whether prices are low or high the beasts must be sold, for the township cannot afford to bring them back. It would be to the advantage of everybody that provision should be made at the principal markets for the resting and feeding of far-travelled stock, and provision made also for their maintenance until a more favourable market if desired by the owners.

Another example: the Highlands and Islands Committee recommended the establishment of a marketing agency to assist the crofter in both his sales and purchases. The Scottish Agricultural Organisation Society has made an encouraging beginning on the latter aspect by taking in orders from township committees, buying in bulk, and retailing to cover cost. This movement is worthy of encouragement and extension. Lastly, and much too briefly—a flat rate for transport is urgently needed on the analogy

of the Post Office. It means an even chance for everybody. The depopulation of the Highlands must continue as long as men and women living in remote and inaccessible places have to earn a hard-won livelihood under the enormous handicap of buying dear and selling cheap because of high costs and distance from markets. And it will be a bad day for Britain when the Islands cease to be the nursery of men who have been born to the sound and the love of the sea.

I summarise the three things needful in seven words:—(1) Individual ownership; (2) State leadership; (3) An equal chance.

G. G. MERCER, C.B.E., Southfield, Dalkeith.

When the war is over, will agriculture, which is the very backbone of the country, be permitted to sink once more into the morass in which it was bogged during the later 1920's and the major portion of the 1930's? This question is one that is never far from the mind of the agriculturist to-day. If we can put faith in the statements of those in authority, and of the city dwellers also, this will never be allowed to happen; but can we blame the farmer if he has grave doubts?

The same promises were made in 1919, and those of us who were farming then know only too well how badly agriculture was let down. It is not inevitable that this should happen again, for, if our fellow-citizens of the towns are willing to make a little sacrifice, there is no reason why the promises they are making to-day should not be honoured.

When the Wheat Act was passed in 1932, it raised the price of home-grown wheat from the ruinous level of the world market price of that day to a point that gave the British farmer a reasonable return for producing his crop, and with its aid many arable farmers were saved from bankruptcy.

Some measure of a similar nature applied to our meat supplies (of which about half the amount consumed comes in normal times from overseas) might put our post-war livestock industry on a sound economic footing.

Not only would the price of fat stock be put on a paying basis, but these better returns would assuredly be reflected in better prices for store stock, and would play an important part in securing for the hill farmer and the breeder of stock on secondary land the measure of prosperity we desire for them.

In oats and potatoes we can be practically self-supporting, and we trust that the great value to the nation of these products, which is being demonstrated beyond all doubt during these days of stress, will have a lasting influence on the dietary of our people, and

that, with the provision of means to dispose of any surplus, a steady market at reasonable prices will be secured.

The benefit to the nation of a good milk supply is now thoroughly appreciated, and one trusts that in post-war days the dairy industry will continue to get for its products prices sufficient to recompense the producer and his staff for the careful, constant and arduous labour that this branch of the industry demands.

The value of the poultry industry to the nation, as the source of one of our most important foods, should be fully appreciated, and the production of eggs and table poultry should be greatly increased. The worth of this branch of agriculture as a market for our home-grown grain is well known. Before the war a large part of our Scottish wheat was sold to supply poultry food.

The duty to provide a market for the surplus foodstuffs produced in the Dominions, and by the Allies who have stood by us in our time of need, is one that must be fulfilled, but, if done apart from a system that will secure for home producers a better price than competition in the world markets will give, then the hope of a prosperous agricultural community will receive an almost fatal blow.

The need for satisfactory prices has been stressed, since only with these will it be possible to pay wages to farm workers comparable to those in other industries, and only in this way will we get our countryside populated by a healthy and contented people. Wages, however, are not everything, and in the days ahead our country folk must be accommodated in houses that not only provide the room that is now considered essential, but also have the accessories that the town dweller deems absolutely necessary. Farmhouse and cottages alike should have sanitary arrangements that satisfy modern ideas, should have a sufficient water supply, and should have electric light and power installed.

There are counties in Scotland to-day where the distribution of electricity is undertaken by the County Council with most satisfactory results. Householders in outlying areas enjoy the same privileges as the inhabitants of the towns, and that at a very moderate cost. This system should be extended over the whole country.

One other point—if the population in our rural areas is to be increased additional houses must be built. County Councils latterly have been closing down houses in many of our villages and accommodating those dispossessed in housing schemes built on the outskirts of cities or towns, and the rural population goes steadily down. In many villages where there used to be quite a little community only one or two houses remain.

This must be stopped, and where rural houses are condemned others must be put in their place: but further, the setting up of

factories in our rural areas is now in many places an economic proposition following the development of water supplies, electric power, and road transport throughout the country. The danger of crowding these factories into certain areas has been amply demonstrated in this war. But their spread would not only make for safety in times like these, but would also enable factory hands to live under healthier conditions, and, at the same time, create a good market for the foodstuffs produced in the area. Thus the repopulation of country districts would be brought about, and the nation would have the satisfaction of knowing that a strong and healthy people, in much greater numbers, was being reared and finding a satisfactory livelihood in our countryside.

THE DUKE OF MONTROSE, C.B., C.V.O.

To-day there are many schemes being put forward for post-war planning, but none of them will be complete, or effective, from a national point of view unless the industry of agriculture be included.

The first " desideratum " is that land and agriculture shall cease to be regarded as political shuttlecocks. They must be treated as national questions, and dealt with solely from the point of view of what is best for the country as a whole. To achieve this end it might be possible to make provision for an Agricultural Commission, somewhat on the lines of the Forestry Commission, whose duty it would be to take charge of agricultural policy and carry on continuously no matter what Government might be in power.

The Agricultural Commission could be divided up into specialised committees, such as for cultivation, dairying, sheep, cattle, horses, implements, fertilisers, feeding-stuffs, etc. All these committees and the Commission itself as a whole should sit from time to time with the Minister for Agriculture to discuss technical questions, and assist in framing policy. Members of the Commission would be drawn from bodies such as the Highland and Agricultural Society, National Farmers' Union and Chamber of Agriculture, Agricultural Executive Committees, Breed Societies, Landowners' Association, etc. The Secretary of State for Scotland would, of course, continue to be responsible in Parliament for the Department of Agriculture as now.

Guaranteed prices for farm produce would seem to be necessary so long as wages are fixed to a legal standard. It is obvious that, unless prices received by farmers cover costs of production, including wages, it will be impossible for them to carry on business. It is likely, too, that wages on the farm will be relatively higher than in the past, and more in line with the standards prevailing in urban industries. All this points to prices for home farm produce being higher than world prices of similar imported

articles. It is not thought that a general tariff system on food products would be tolerated in this country, even for the purpose of "ironing out" inequalities found to exist between home prices and imported prices, and, therefore, it would appear that the easiest way to surmount the guaranteed price difficulty is to approve in principle an extension of the existing wheat deficiency payment policy which has proved so satisfactory in practice. Of course, some adjustment would require to be made to meet the varying conditions of farm production, but the same principles of application should be observed. Some people seem to look to "land nationalisation" as a panacea for all the ills of agriculture, but no proof has been given to show that a mere change of ownership of the soil will cause two blades of grass to grow where one grew before. It is known that land purchase in Ireland cost the tax-payers in this country many millions of pounds; and it will cost them many millions more to do the same thing now throughout England and Scotland. The main result of such expenditure would be to allow the present occupiers to continue to live on the same land they occupy to-day, and cultivate it in the same way. There are no other people to take their place. Apart from land nationalisation, there is room for improvement in the existing forms of occupying tenure; take, for instance, smallholdings; they cannot be said, as a general rule, to be a financial success on private estates. The policy of "fixed rents" has dried up all chance of landowners being able to add permanent improvements to such property, for, in common with other people, they are not in a position to afford the expenditure of large sums of money from which no return can be obtained, and the fact of rents being fixed prevents any return from that source. It looks, therefore, as if smallholdings in future will only be possible on land owned by public authorities or the Government. The Government should be able to obtain the necessary land by voluntary negotiation. The transactions of the Forestry Commission would seem to indicate that success will attend this method; they have acquired by purchase, or feuing, not less than one million acres in twenty years. Then it might be enacted that agricultural land will be accepted in settlement of death duties, and at the value put upon it for assessment by the Revenue authorities themselves; when the land has been obtained it could be laid out for leasing in lots of any size at fixed rents to sitting or other approved tenants.

Many private estates are financially crippled by heavy burdens in the shape of family provisions, annuities or mortgages. Other forms of business are not burdened with similar impositions; why should the land be? It should now be made illegal for a landowner to burden or mortgage his land except for an authorised productive improvement.

Damage by game has been a thorny subject for many years, and it seems to grow more acute as time passes on. It would seem now that the fairest solution for this problem would be to vest sporting rights in the occupier of the land, leaving it to him to lease these rights to whom he likes, or keep them in his own hands; but, of course, the occupier would have to pay all rates and taxation in respect of the sporting rights.

There would, unfortunately, seem to be justification for complaint regarding the inferior housing conditions on many farms. Landowners ought to be encouraged to put this right without delay. One way of doing this would be to grant a rebate of income tax, say for 10 years, on rental received from capital invested in erecting working-class dwellings; so long always as the net rent did not exceed 3 per cent. on the capital expended. A policy of this sort might help to encourage money remaining at home instead of going abroad for speculative investment.

There should be an easy system for landowners or farmers to obtain financial credit at low rates of interest. The system should operate through the local banks, and be prompt and without red tape. It is not a good thing that farmers should be tied so much to merchants through financial obligations. The credit should be available for stock and crop operations as well as for permanent improvements, erection of buildings or purchase of land.

As regards transport, there should be a flat rate for the carriage of farm produce to central markets, whether by road, rail or sea. No matter where the goods may be produced, it should be possible to place them on the market at the same cost to all farmers. It is not fair that, given two farmers " A " and " B," equally skilled, and equally hard working, the one should be able to send his produce at so many shillings in the pound cheaper to the wholesale merchant, just because geographical distance is in his favour It is this sort of competitive handicap that is stultifying work on so many distant farms or driving their occupiers into the towns.

Co-operation is another line that can be greatly developed. The Agricultural Executive Committees have already shown what can be done in establishing a " farm service " with implements of all kinds. It looks as if most of the cultivation operations, and even the breeding, will be done in the future by " hiring " machines and pedigree sires. Co-operation, however, will never achieve all it might do unless it includes the appointment of official agents to collect, grade, pack and sell produce. This is particularly important in scattered places like the Western Highlands and Islands. The co-operative agents would have to be salaried Government servants, for they can never be maintained by voluntary subscriptions.

It will be seen from the above remarks that improvement in the position of agriculture is sought more by evolution than by

revolution; and this by acquiescing in the tendency of the times in regard to progressive surrender of private rights to the Government. All things point towards the breaking up of large estates with saving to landowners on the many calls which they have borne in the past. They may rest well content if they are allowed, in the end, to enjoy an acreage which they themselves can look after and manage agriculturally. This would mean more resident ownership and less absenteeism, which would be all to the benefit of Scotland as a nation.

SIR JOHN BOYD ORR, D.S.O., M.C., M.D., F.R.S.

In pre-war days, the many different agricultural problems were dealt with as if they had little connection with each other or with the wider general economic problem. The Government, anxious to appease the farmers, devised piecemeal measures for different branches of the industry in the form of Marketing Boards, quotas, tariffs and subsidies. There was no common principle behind these measures. There was no agricultural policy. Indeed, we had no economic policy except one of trying to patch up the old structure in the places where a breakdown was imminent.

Most people who have studied the question now realise that more is needed than a series of patchwork measures. The economic system, which came to full fruition in the nineteenth century, broke down in the 1914-18 war. After being patched up on the old model, it wobbled in the economic crisis of 1929 and has now crashed beyond repair in the present war. It is obvious that drastic changes are needed, and a number of unofficial committees have arisen to study the position and outline plans for the future, and, indeed, the Government has set up a new department for this purpose. The future of agriculture depends upon the general nature of the plan for the future, and it is a waste of time to consider an agricultural policy until the general policy is known.

There is reason to believe that the objective in planning will be, not the maintenance of vested interests, but the welfare of the people. Mr Churchill has spoken of the "fuller life of the common people." Mr Roosevelt has said, "We plan now for the better world we aim to build. There must be more abundant life for the masses of people of all countries," and then he refers to "the millions of people who have never been adequately fed." Expressions of opinions such as these, coming from the heads of Governments, justify the belief that the democratic Governments are determined to get back to the fundamental principle of "government by the people for the people" and that, therefore, the first duty of Governments will be to provide the necessities of life for the people governed. By the necessities of

life we mean the material and spiritual environment which will enable all the people to attain their full inherited capacity for physiological and psychological well-being.

Let us consider now the position agriculture will take in this projected new world order. We know the amount and kind of food needed to maintain people in full health, and we can estimate the amounts of the different foods which would be consumed if consumption was not limited by purchasing power in any part of the population. Government departments in the United States, as the result of extensive investigations, find that the diet of nearly half of the population is inadequate for health, and have estimated that, to bring the diet of the whole nation up to the level now known to be necessary for health, production of the more expensive health foods would need to be increased from 15 per cent. in the case of butter to 100 per cent. in the case of citrus fruits and vegetables. These increases are called for, not for export, but to provide the food which the population of the United States needs to bring their health and physique up to the much higher level which we now know can be attained by proper feeding. The position in the United Kingdom and in the Dominions is probably somewhat similar, with the exception of New Zealand, which is the best-fed nation in the world, with the lowest incidence of disease and infant mortality rate and the longest expectation of life in any nation.

If agriculture is to fit into a general scheme planned in the interest of the common people, then political measures for restricting the production and distribution of food must be replaced by the application of all the science we have to increased food production, and the sweeping away of all barriers to the distribution of food.

Such a scheme will bring about a revolution in British agriculture. We shall need to plan for a great increase in the production of the more expensive protective foods which we can produce as economically as any other country. The most important is milk. We shall need to increase milk production by 30 per cent. to provide liquid milk without having any significant surplus for manufacturing into butter and cheese. There will need to be an even larger increase in the production of vegetables, eggs and bacon. British agriculture would become more like that of Denmark. We shall need also to increase our imports of food, especially of feeding-stuffs. The increased food production will bring prosperity to agriculture. The increased trade in food will be good for business. Our farms will need to be reconditioned. Our rural workers must have the same standard of living in housing, furniture and clothing as men of equal skill in urban industries. We shall need to expend hundreds of millions of

pounds in reconditioning agriculture. This will give an outlet for industrial products which will go into the rural districts in exchange for the increased output of food. In the same way, our increased imports will need to be balanced by increased exports of industrial products to pay for them. If we are going to have a plan for the welfare of the common people, we must have a food policy based on human needs and, as we can estimate what amounts of foods are needed, it is easiest to begin to plan for food and make the plans for food the spearhead of a movement for agricultural and commercial prosperity which will be based on the promotion of human welfare.

It is realised, of course, that this scheme would involve a complete rearrangement of trade agreements, of tariffs and the provision of financial credits, but the necessary arrangements in these matters have already been made to enable us to prosecute the war. They can as easily be made to enable us to build up "the better world we aim to build" after the war.

I have purposely dealt here with the wider issues because it is a waste of time to work on detailed plans for Scottish agriculture unless these plans fit into the general scheme of the democratic group of nations which will ultimately become the general world scheme.

C. S. ORWIN, Agricultural Economics Research Institute, Oxford.

Before the war broke out, the prices of agricultural products in the international market were such that there was nothing which the British farmer could produce to sell at a profit. Everything which he was producing in 1939—grain, meat, dairy produce and horticultural products—enjoyed some kind of protection, by tariffs, subsidies, import regulation or otherwise. Agricultural assistance was given without discrimination; there had been no attempt to take advantage of the farmers' need for help so as to control or to direct production with the object of encouraging the output of those commodities of particular value to the country and leaving any others to take their chance.

After the war, it seems quite certain that protection of farming will have to remain, unless we are prepared to see the decay and perhaps the virtual extinction of rural industry and social life. The grain elevators of the exporting countries will be bursting with the unmarketed surpluses of the war years, the cold stores will be full of meat and dairy products, while there will be the largest reserves of animal products "on the hoof" which the world has ever known. A starving Europe may be able to absorb it all, but it seems clear that it will be a long time before the world market will settle down, and that the chances of unaided competitive trading by British farmers are remote. In the meantime,

those who know their business are making big profits under war-time control, wages are rising, and it is impossible to contemplate the general collapse of all rural industry which would occur if all assistance were withdrawn.

It seems, then, that the only questions for consideration arising out of the immediate post-war situation are the nature and the extent of the assistance which agriculture should have. A selective protectionist policy seems clearly to be indicated, public assistance being given to encourage farmers to concentrate their efforts on those commodities, and those only, which the community who has to pay the piper needs most. What these will be will depend entirely upon the nature of the settlement after the war. If this should be such as will remove all fear of war for long years to come, the national policy should be directed towards stimulating the production of all the so-called "health" foods, the dairy products, meat and poultry products, fruit and horticultural products. Such a policy would not necessarily exclude all assistance to corn production, but care should be taken not to encourage it by excessive prices. The principle embodied in the Wheat Act supplies both the means and the safeguards, provided that the quantities of the corn crops to which the full deficiency payments would apply were not fixed too high. Sugar beet, in theory, would have to go; there could be no possible case for subsidising it under a peace-time farming policy. In practice, its artificial existence during the past sixteen years will be found to have created a vested interest which it will be difficult to ignore.

If, on the other hand, the post-war settlement should leave Europe an armed camp, with the possibility of war still to be reckoned with, a selective protection of farming is also indicated, but with an incidence modified to meet the altered circumstances. Emphasis would have to be laid upon those products which would give the nation the greatest number of nutrient units. Wheat, oats, potatoes and sugar beet would assume first-class importance once more, while, among animal products, milk production for liquid consumption and for cheese would have to be encouraged to the uttermost. After dairy cows, pigs and poultry should follow in order of preference, being the next best converters of feeding-stuffs, leaving beef cattle and sheep to be produced only so far as grass-keeping and any surplus feeding-stuffs might allow.

In the after-war period, then, the country must expect to have to pay for its agriculture in one way or another, anyhow for a time, and this necessity should be used to direct farming towards the production of those things which will serve the nation best according to its circumstances at the time. As a national post-war policy, however, this will not be sufficient. The State will have to consider further the problem of the maintenance of the per-

manent equipment of the land for farming. It is generally admitted that the partnership of landlord and tenant is breaking down, and that the difficulty of the landlord in executing repairs and providing replacements is likely to be enhanced as a result of the impoverishment of the country. Most of the remedies proposed, which take the form of the remission of taxation, would make investors in land a privileged class and are unlikely to carry conviction. The problem is a real one, and, as one of the purposes in subsidising farming is to maintain a prosperous rural society, the State will have to consider whether the time has not come for it to take over the landowners' functions.

Whatever steps are taken, either for the short-term or long-term policies, it seems unlikely that special provision will be required for Scottish agriculture. Scottish farming could adapt itself equally to the peace production policy as to a policy based on the possibility of further war, and the high standard of efficiency amongst Scottish agriculturists should enable them to hold their own in any conditions adapted to the requirements of the rest of the country.

PRINCIPAL W. G. R. PATERSON, O.B.E., B.Sc., West of Scotland Agricultural College.

The war has made the townsman food conscious and, whilst the battle rages, measures to strengthen the home food front will be readily conceded. The tremendous increase in home food production during the past two years is an indication of what can be accomplished if encouragement is forthcoming. Agriculture is playing a vital and honourable part, indeed, so notable a part as to show that there was every justification for the long years of crying in the wilderness. The Cinderella of British industries has blossomed forth in no uncertain fashion, but it must come to be equally well appreciated that a prosperous agriculture is likewise a necessity in peace time, constituting as it does a big factor in national stability, and enhancing urban as well as rural welfare. Ours is a great industrial country, but, as agriculture is the primal industry, schemes for reconstruction in post-war Britain must give it a place as one of the chief pillars of our economic structure Considered from many viewpoints — the need for population, economy in future to pay for present indebtedness, the nutritive value of fresh foods rapidly marketed, and the insuring of a greater stability in a disturbed post-war world—we cannot afford to neglect our land as we have done in the past. There is great diversity in farming systems, but all must be encouraged to give of their maximum by sympathetic policy, efficient advisory services and good farming. All but the utterly useless land should be put to a worthy use. Landowner, farmer and the State must

realise that in the land of Britain they hold, in trust, a great heritage to be handed down unimpaired or, as is the fashion with good husbandmen, improved.

Advance in scientific knowledge has made it possible to achieve and maintain a very high level of output, and our policy should be that of maximum economic production from our own soil. That this to a large extent depends on an assured market and a price based on production costs is evident from the present war-time increase when these conditions prevail. The cry in the past was for cheap food for the towns, the consumer heeding little the working conditions of the employed or the return to the employer. The same consumer, however, had his trade union or similar body to prevent urban labour being sold in the markets at too cheap a rate. In contrast, a considerable proportion of the food consumed here pre-war was obtained at a price below the long-term cost of production.

There is a clear call for agricultural planning and a vast problem awaits skilled, patient and imaginative handling. Man is showing his terrible ingenuity at present, and no war-time problem is long unsolved. Surely some of the same intellectual skill can solve the problem of agricultural prices, perhaps over areas extending beyond national frontiers.

To encourage British agriculture we must balance the volume of suitable home production against alternative imports. Part of what we shall need cannot be produced here, while for other foodstuffs comparative production costs will always favour imports, but, in a country so fertile, so climatically favoured, and, on the whole, so skilfully farmed, there is great scope for increased output. We must develop the fresh milk market from the nutritive aspect and encourage beef production to keep the plough going, maintain fertility, give a balance to our farming, and give the urban areas more than a taste of the finest beef in the world. Intensive pork and egg production are best as " near the market " activities. The day for early lamb will come again. Over the huge areas of rough grazing, sheep farming and its ancillary cattle raising must be given a firmer grip. It is only by working for the maximum possible output, per unit of area, over the land as a whole that we can employ the maximum number of people at a good standard of living.

State policy directed to similar definite ends will probably entail some measure of State supervision or control. The nucleus of such decentralised, essentially local, administration exists to-day in the Agricultural Executive Committees. Assuming their continuance in peace time, some changes, including stronger technical representation, might be advantageous. But even within a State policy of agreed prices and of *what* and *how much* to produce,

the conditions of production will require consideration. State help, if forthcoming, will go hand in hand with a call for maximum efficiency in production. In this respect, and keeping in mind the widely varying soils, climatic conditions, and traditional methods of production, many farms are too small for economic working. Apart from small-scale specialisation the greatest hope for the future in all the better farming areas would seem to be in the medium-sized stock or stock and cropping farms of from 200 to 400 acres in extent. Such farms are not too small for the adoption of a fair measure of mechanisation, nor are they too large for the very great advantage that accrues from personal supervision and direction. In the case of very large farms that is impossible and much is lost thereby—

"He that by the plough would thrive,
Himself must either hold or drive."

Discussion of farming efficiency leads inevitably to-day to consideration of land tenure. It is being repeatedly asked how far will State help in increasing output and in assuming some of the landowners' functions lead to land nationalisation. Over all, there is no better system than that of proprietor and tenant, provided the former prizes his heritage, is interested in the land, in rural life, and in the welfare of his tenants, and that he has adequate capital to discharge his responsibilities in the partnership. The other partner—the tenant—must be keen, knowledgeable and progressive, with adequate capital to lime, manure and crop and stock for maximum output. Happily there are still many estates on which such conditions prevail. The present alternative, that of occupying-ownership, can truthfully be said to be the ambition of a large number of farmers, excepting where tenancy conditions are very good. Given capital in sufficient amount to stock and farm well, or access to credit on reasonable terms, an increase in occupying-ownership is desirable, catering as it does for one of the oldest and deepest desires in life. To replace effectively either of the above systems would mean the gradual evolution of a body, highly decentralised, efficient, rapid in decision and human in its dealings.

In education and research we have examples of State help for which the industry owes a debt of gratitude. In the past 25 years, agricultural education, research and the advisory services have given invaluable assistance in difficult times. But, here again, advance is necessary. The successful farmer and worker must be well educated technically to meet modern conditions. It will be the increasing function of the colleges to provide teachers to extend agricultural education, to give a lead to the organisation of Young Farmers' Clubs and, through an increased number of county organisers, to make, in growing number, the most valuable of all

educational contacts, namely, those with the farmer himself on his own farm among his own problems.

Dealing specially with Scotland, we must pay particular attention to solving the problem of maximum use of rough grazings and the foothill land between the hills and the low ground. Our high-quality beef production is relatively of greater importance than in England, and needs a skilled policy to maintain export standards and give the beef farmer a fair chance. We must be careful, too, that our afforestation policy does not unduly compete with or hinder hill sheep farming.

G. H. RUSSELL, The Burn, Glenesk, Brechin.

"The war now has left us nothing to keep: we have all to get, and the work must be done by ourselves. I say, then, you must contribute money, serve in person with alacrity, accuse no one, till you have gained your objects; then, judging from facts, honour the deserving, punish offenders; let there be no pretences or defaults on your own part; for you cannot harshly scrutinise the conduct of others, unless you have done what is right yourselves."—Demosthenes, *The Second Olynthiac.*

Just as the thoughts of a grandson of The Mearns, in the brief intervals of the almost incessant toil on his father's farm in the South-West of Scotland, found expression in the wish:—

"That I for poor auld Scotland's sake,
Some useful plan or book could make,"

so a son of the South-West whose lot is cast in The Mearns welcomes the opportunity to make a humble contribution to the discussion on post-war agriculture in Scotland.

No amount of special pleading will clear the great bulk of the nation of connivance at the guilt of successive Governments in their studied neglect of one of the greatest industries of this or of any people.

Twice in a generation agriculturists have had to answer the country's call when it was nearly on its beam-ends. After the last war there was a flash-in-the-pan prosperity which happened at a time when it was practically impossible to carry out improvements. By the time demobilisation had been completed, when the work would have been welcomed, the disastrous slump had set in, when prudent landlords, owner-occupiers and farmers no longer felt themselves justified in launching ambitious schemes requiring heavy capital expenditure.

So the resumption of war in 1939 found the industry facing the problem with depleted bank balances and with worn-out tools. And now, once more, the cry is "Never again."

In spite of our eminence in trade and commerce, the root stock of the race is from the land. The longing for land played a great part in the lives of both Celt and Saxon. The tides of immigration were not all due to motives of plunder, but were impelled by the need of and the urge to seek new homes. Even in American colonial days, and later in the nineteenth century, the force behind our great colonising movements was the desire to open up the unoccupied territories of the world.

The war has familiarised many people with discipline; it is well that this should remain; but it need not be oppressive. Just as a man may not command a ship or manage a mine without showing proof of his training and competence, so should it be impossible for a man—be he landlord or tenant—to occupy land in such an inefficient manner that by doing so he constitutes a nuisance to his neighbours and a disgrace to the country. While Agricultural Executive Committees may be disbanded the lessons learnt from their service should not be lost. A carefully selected and fairly balanced tribunal should be created which would be empowered to deal with complaints, and which, after giving fair warning, could call offenders before it and, if necessary, have them removed from their holdings, or, in cases of landlords, control the future direction of operations on their land.

Taxation of land should be revised on the principle that indiscriminate taxation has been found to exhaust the land. The fact that inanimate bodies such as colleges and large corporations buy land freely is a proof that, provided they are free from the incubus of death duties, they regard land as a reasonable investment.

Farmers will have to alter many of their ways. Long-term engagements will tend to diminish as the result of high wages and the burden of expense of perquisites which is never fully realised by the public. Insurance, coal, dairy cows, to mention a few examples, are on a very different level from former times. With increased mechanisation a new race of rural contractors will spring up who will undertake many of the jobs on a farm. There will be more piecework. A farm's permanent staff will be nuclear, capable of expansion at times of seasonal pressure.

One of the most profitable lessons which the stress of war has taught us is that valuable time can be saved by stacking in or near the fields. There are obvious objections to encumbering the latter, so, with as little delay as possible, farmers should look out permanent sites where stathels could be erected. A little ingenuity will show that places such as the ends of plantations or shelter belts or points where two or three fields meet will insure that the stathels are kept in regular use. There is still need for perfecting a vermin-proof stathel. If the professional designers of the great cement combines or the makers of modern pre-fabricated materials

would apply their minds to this problem they would be performing a valuable service to the country.

Care must be taken to avoid the loss of the valuable constituents of dung. Knowledge of this subject has been widely disseminated, so the country should no longer tolerate ignorance or indifference. Much requires to be done to improve the amenities of rural life. Housing calls for a drastic overhaul. There is a crying need for improved water supplies and electricity. With the coming of shorter hours of work there must be opportunities for the better use of leisure. It ought to be possible for good education to be within the reach of all. The Service system of " courses " might be copied, to which suitable candidates could be sent on the recommendation of and possibly with assistance from such bodies as Farmers' Clubs, the Highland and Agricultural Society, or from County Education Committees, but, as a prerequisite, all candidates ought to have had some common grounding either at school or after leaving school, so that they will know how to live in a community, and be able to take full advantage of every minute of the course.

The case for a revival of agriculture is inseparably bound up with the needs of the health services of the nation. The price that we have had to pay for industrial supremacy is painfully evident. There is a too obvious disparity between selected 'lives, like the men of the Royal Navy or Royal Marines or of Dominion troops, and many of our own men who wear the uniforms of our proudest regiments. The position may be better than it was, but still the general average is far too low. Those who are familiar with the physique of continental peoples confirm this impression.

Is this due to unwholesome over-civilisation, to chronic undernourishment for more than one generation, or to the stresses and strains of modern life? The records of hospitals show the disturbing number of gastric and digestive diseases, the flaring advertisements of patent medicines in every newspaper are pointers to the law of supply and demand.

If we are to survive we must give very serious thought to questions of a more healthy balance between city life and country life. War has taught many town dwellers to look more favourably on the country.

There is no use attempting to stem the flood-tide of migration from country to city. It is inevitable that the ambitious will seek the wider opportunities which life in larger communities offers, but it ought to be the birthright of every child that a large part of the growing and impressionable years of his or her life should be spent in the country. Many people will be fortunate in having relations and friends to whom they can entrust their children, for others the possibility of the development of a widespread *au*

pair system needs careful study: young city children coming to the country in exchange for slightly older children whose parents will welcome the wider opportunities of education. For those who cannot be absorbed by private effort the remedy lies in the pages of Sir George Stapledon's works.

All this would bring prosperity to the country.

Some may say that the case is hopeless, and that our race has passed its zenith and that we are rapidly descending in the scale of nations, but this is not the time to strike a note of pessimism. Other nations have made mistakes, and under inspired leadership have thrown off their lethargy and restored their vigour. But the indispensable condition is that the work must be done by man himself.

"... Make you a new heart and a new spirit for why will ye die....

"For I have no pleasure in the death of him that dieth saith the Lord God. Wherefore turn yourselves and live ye."

PROFESSOR ERNEST SHEARER, Edinburgh University.

It is accepted that agricultural policy cannot be considered apart from our general economic structure, or from the conditions in relation to colonial and foreign trade imposed by our position as a highly industrialised State. In the past, indeed, undue weight may have been given to the latter consideration, but a great step forward has been taken in recent years in the general recognition of the importance in the national economy of an efficient and prosperous agriculture. The progressive decline in agricultural production which has marked the last 60 years has left a long leeway to make up, but what, in face of great difficulty, has been achieved in the last two years gives indication of the progress that might be looked for under a well-conceived and energetic agricultural policy. Some of the essentials in such a policy are briefly reviewed.

In practical ability our British farmer can hold his own, but at the present stage of development of agricultural science this is not enough, and he stands in need of every aid which agricultural research and education can give him. On the whole, he is no longer backward in availing himself of the advisory services open to him, but to make these more fully effective and to ensure a higher degree of self-sufficiency there is room for great advance in agricultural education at its various stages—Nature Study and Rural Science Instruction in Schools, Continuation Classes, and Courses at Colleges and Farm Institutes. The machinery is in being, but it wants overhauling and strengthening. In particular it wants such support from Education Authorities and the farming community as it has not generally had in the past. In recent years the State has not been ungenerous in its support of agricultural

education and research, and, while many Local Authorities have risen to their responsibilities, others have given only lukewarm support.

In other directions the State has been active in aiding agriculture—in promoting legislation for the establishment of marketing boards, in the payment of subsidies on agricultural produce and on the use of lime and slag, in developing and assisting drainage. While subsidy payments have been generally regarded as temporary expedients it is essential that price control in some form should be maintained. We have only to compare the yield and cost of production of, say, sugar in Cuba and wheat in Australia or Canada with that of the same articles in our own country to realise the climatic and other handicaps under which the British farmer labours. The maintenance of prices at a satisfactory level—high enough to give an adequate return, not so high as to encourage inefficiency—will do more than anything else to attract to the land the capital required to make good the deterioration in farm equipment which has been an all but universal accompaniment of the bad times in British farming, and to make possible the development of productive farming enterprises involving substantial outlay.

No more fruitful assistance has been given to the farming industry than that embodied in the policy of raising the general level of soil fertility by subsidising the use of lime and slag. The practice of liming, so important for its general effect on soil condition, which had largely fallen into desuetude has had a welcome revival. As yet, however, only a fraction of the ground in need of lime has been dealt with, and it is to be hoped not only that the present subsidy will be long maintained, but that the Government will see its way to shouldering such additional share of the cost of transport as will encourage the use of lime in districts remote from sources of supply, which often stand most in need of it. It is also to be hoped that opportunity will be found to restore the subsidy on slag recently withdrawn. On these two fertilisers primarily depends the successful exploitation of our marginal lands, whose extent and low level of productivity fall little short of a national reproach. The technique of dealing with such land—largely bound up with the use of mechanical power—is now well known, and, though initial costs are considerable, substantial dividends are forthcoming almost immediately. Nothing would be more indicative of a live agricultural policy than a vigorous tackling of this situation.

The maintenance and development of drainage, another of the primary essentials in agriculture, is largely dependent for effectiveness on central direction and co-ordination, and therefore must continue to demand a large measure of State support.

The levelling of transport costs, alluded to in connection with the lime subsidy, is a principle of wide application, and is of special importance in the development of more remote districts such as the Highlands and Islands where existing freight charges—inward and outward—impose severe burdens on regions already sufficiently handicapped by poverty of soil and inhospitable climate.

Conditions of land tenure intimately affect any consideration of agricultural policy. The traditional landlord and tenant system has broken down as an effective method of land exploitation, and wide support is forthcoming for the principle of State ownership, which is backed by the proposition that the development of mechanical power demands large farming units and so has put out of date our general farming structure. On this latter point it may be answered that the tendency to specialisation, for a considerable time apparent in our agriculture, must go on increasing, and that farms for the production of livestock and livestock products need not be very big; also that reasonably effective use of power can be made on farms of, say, 300-500 acres. State ownership on a substantial scale may be well worthy of a trial, but it is doubtful if it can give sufficient scope to those qualities of initiative and enterprise which may be looked for in the other alternative to the existing system—occupying-ownership, already functioning to substantial extent.

Finally, it is generally accepted that no agricultural policy can succeed which does not provide for the farm worker standards of living, housing amenities and social and recreational facilities comparable with those available to his town brother. Much progress has already been made in this direction, and there is little reason to doubt that the establishment of a prosperous agriculture will go a long way to providing a way of life for the country worker which, on any reasonable standard, will compare favourably with that of the town dweller.

A. G. STREET, Author of "Farmer's Glory," etc.

Assuming that even a farmer has sense enough to confine his writings to those subjects of which he has some real knowledge, be it understood that the following notes have reference only to that portion of British agriculture that lies south of the Cheviots. How far the suggestions they put forward may be applicable north of the Border it will be for others to say. With that definite restriction, what should the position of farming be after the war, that is to say after victory has been won by Britain and her Allies?

The answer to that difficult question comes in two distinct parts. Firstly, that there shall be a new conception of agriculture's place in our national life; and, secondly, that there shall be adequate

control of farming to place that new conception upon a sound and lasting basis.

For the sake of regularity the pre-war conception of agriculture's place should be defined. It varied in accordance with the politics of the individual, no matter whether he or she were merely voter, member of parliament, cabinet minister, or peer. Those of the immoderate Left looked upon farming as a hopelessly inefficient, out-of-date and unimportant nuisance that could very well have been done without, leaving the countryside as a playground for the masses. Those of the equally immoderate Right valued farming as a charming British tradition that should be preserved with all its faults, no matter how great the expense. Only a small minority of the population, those unfortunate folk, either landlord, farmer, or farm worker, who depended upon it for their livelihood, looked upon farming correctly, as a business, and a highly important one at that.

After the war, then, everybody must look upon farming for what it has been, and then will be—the fourth largest industry in the country and the nation's fourth line of defence in time of war. To achieve this new conception it will be necessary to raise the status of the farming industry in the public's estimation, and the only way to do this will be by enabling it to pay to its workers at least ten per cent. better wages than they could earn by comparable work in towns.

People can argue until further orders about this, but the fact remains that during the last hundred years the troubles of farming have been almost one hundred per cent. economic. For many years rural parents, aided and abetted by rural school teachers, have brought up their children to look upon farm employment as something to be escaped from if possible. To-day, even during a war, the nation values its farm workers as the lowest of the low and pays them accordingly. There must be an end to this state of things, and the generally accepted argument must disappear that if a farm worker earns X pounds every town worker must automatically earn X plus so many more. Only when a rural wage standard has been reached whereby farm employment becomes something for the efficient to seek after as a prize can farming take its rightful place in the life of the British nation.

That just wage standard in agriculture can be achieved only by a thriving farming industry that is able and eager to pay it; the cost will have to be met largely by the town-dwelling consumers of food in this country. Even when they are in mortal fear of famine they continue to deny a rightful wage to those who produce food at home, so it is absurd to imagine for one moment that they will pay for a decent agriculture here at home

when overseas food in plenty arrives here once again, unless they are given something in return, something that will assure them that any national investment in home farming will not eventually reach the pocket of the private owner of land, or will be wasted by inefficient or shortsighted methods of farming. Curiously enough to-day most of them are far more concerned about the latter possibility than the former.

But both must be safeguarded against—there must be control of land and also control of farming. Whether these two be achieved by land nationalisation or by a furtherance of the work of the existing War Agricultural Committees is perhaps immaterial; the points to note are that it is impossible to control anything in penny packets, and that control of actual farming operations must be decentralised.

The private landlord, having been robbed of the necessary control, a new landlord, the State, must take on the job. But this new large landowner must have sense enough to delegate the actual control of agriculture into suitable districts, counties or even rural districts. These, in their turn, must have sense enough to leave the actual farming operations to the only people who can perform them properly, the farming community. They must be careful to lay down no rules directing what their tenants *shall do,* but should be content to copy the practice of the old-time private landlord by laying down rules stating explicity certain things that their tenants *shall not do.* These rules would be aimed at preventing the type of farming that would result in robbing the land of its fertility. Thus, if a man wished to keep cattle, sheep, or pigs, he would be free to choose. If he wished to grow cereals, grass, or roots, he would be free to choose. But overcropping, allowing land to become foul, and similar farming crimes would be heavily penalised.

The result would soon be seen in better farming and higher rents, both a benefit to farming and the nation in general and the district in particular. In addition, there would be a general movement of the best Britons to the countryside, either as farmers or as farm workers. In short, an agricultural life would soon be considered a prize to be won, instead of what it is to-day, something to be shunned.

SIR JOHN SUTHERLAND, C.B.E., LL.D.

The position of agriculture in the economic structure of the State after this war is over must be prominent. Rural life should be resurrected, encouraged and increased. The soil is our great heritage, and the full utilisation of it has fallen low because there has never been a comprehensive land policy in Britain. Well-conceived proposals for legislation with progressive aims have

frequently been lacerated in Parliament through political feuds. Schemes for holding settlements cannot claim for the due betterment of the people who have adventured upon them. The location of settlement, the terms, conditions and circumstances generally have not had the attention required. This applies to England as well as to Scotland. The Departments have struggled in both countries, and struggled well, to administer the Statutes that have become law, but they have never had a fair chance for the reason that there has been a complete absence of national policy. Legislation over many years has been the result of periodic pressure: when bankruptcy is threatened as when the price of barley and oats fall—snapshot belated attention to the condition of our greatest industry and in no sense constructive. As a foundation of land policy a systematic survey should be made of the land surface, and with it an allocation of the areas to be earmarked for agriculture, sylviculture, horticulture and all other products to be grown. It may then be possible to estimate the quantity of grain and other crops and meat which should be available. The nation can consume everything that can be raised from the soil, and this seems the outstanding feature of our position. While crops and meat can be raised in Britain as good in quality as in any other country, they cannot be sold in competition with imported produce of the same type. This is the unfortunate economic situation. If farming had been reasonably profitable during the last decade there would have been no cause for the great and expensive urge of to-day. For the future the endeavour must be to see that the soil is continuously utilised to the best advantage, and that cultivation is maintained upon sound principles. Prices must correspond to the cost of production, plus a reasonable consideration for capital, skill and labour. Subsidies have never been favoured, but they have come and must remain for our own security, unless the whole commercial course of the world is altered as a result of this war. Britain is too small in extent for the institution of farm settlements on the same basis as those created in Russia, nor can large-scale farming compete with the crops of prairie lands in our Dominions. Neither can nationalisation of the land prove a cure for our economic prostration. The farmer is an individualist—his stock and his crop appeal to him in that sense, and grandiose schemes will not have his interest, his endurance or experience. It is doubtful also whether nationalisation or large-scale community farming, taking all charges into account, would either increase production or lessen the expense of it. A scheme of land purchase, as in Northern Ireland, and another for the creation of peasant ownership might well be considered, but in both there would have to be State direction and assistance. It is suggested in some quarters that railways should be owned and controlled by the State,

but, whether this is done or not, there is need for a revision of rates for agricultural produce. The present rates have a material bearing upon agricultural progress in the areas which are situated far from the centres of consumption.

Whatever may be the nature of the policy for land, when launched it must be enduring. The basic principles should apply to the country as a whole, but England and Scotland will require separate treatment and the conditions in Wales cannot be ignored. Treatment suitable in Northumberland may not apply to Dorset, and the needs of the Highlands bear no resemblance to the requirements of Midlothian. The change, in whatever garb it may be clothed, will come at a time when general reconstruction of industries will be afoot; but in agriculture a gradual process of change would seem best in all interests.

A sad aspect of the whole subject is the absence of public interest. As in 1914-18, so now the farmer and the farm worker are much applauded. They must not be forgotten when this struggle is over, and some means should be adopted to keep the homeland and the fruits of it more steadfastly before the people

PROFESSOR J. A. SCOTT WATSON, Oxford University.

From the economic point of view the aim of agriculture is efficiency in food production—production of good food at the lowest price that is consistent with fair and reasonable wages, profits and rents. We should aim at keeping in fertile and productive condition so much of our land as is likely, in the long run, to be worth farming. With few exceptions, the question as to what the particular piece of land should produce is merely one of what it can produce best. We must scrutinise very closely any proposals designed primarily to put more men on the land, to bring poor land into production or to favour some particular size of holding or the production of some particular commodity. "Social" gains are apt to be illusory if they imply serious economic losses.

In my view the means towards a permanently flourishing agricultural industry should be three. In the first place, if food is to become progressively cheaper and if, at the same time, farmers and workers are to share in the benefits of progress, we must aim at continuous improvement, at the maximum possible speed, of the processes of production. This implies more research and invention, better technical education of each successive generation of landsmen, and a more efficient and faster-working system of bringing new knowledge, new materials and new machines to the notice of the farmer or farm manager. It is notorious that we have done less in these ways, at least in relation to our wealth

and resources, than most other countries; and we have suffered by our neglect.

The second need is for better-planned markets and more stable prices. In the past hundred years a good deal of British land has been reclaimed, equipped, staffed and brought into production two or three times over, only to be abandoned again or allowed to fall back to a very low level of productivity. Landlords' money has been sunk and lost, men have been employed and thrown idle, farming skill has been lost to the nation because skilled farmers have lost their working capital. All this has caused a loss of confidence, has discouraged enterprise and has meant a great waste of effort. The nation should take longer views; it should not stand by and see its soil ruined by the accident of a surplus in the world food market.

Thirdly, the nation should ensure that its land is used in the national interest. Much good agricultural land has been taken for purposes that did not require a fertile soil. Much more has been abused by landowners, land agents and farmers whose possession of capital failed to make up for their lack of knowledge and skill. The ownership or management of land should imply the duty of reasonably efficient use. The possession of capital must not remain the only qualification for the right of use of land. Some system of supervision and control, with the right to dispossess, would seem to be essential.

PROFESSOR R. G. WHITE, University College of North Wales.

In replying to the questions put by the Editor, one would like to adopt what is said to be the usual Scottish method, and to begin by asking others. These would include several regarding the assumptions which are to be made about post-war conditions both in Great Britain and in the world generally. As there is no hope of obtaining definite answers to such questions, it seems best to take a few relevant facts as a basis and to build on them as far as possible.

1. Our population has to be fed, and there is need for improvement in the national dietary, particularly in the case of children, though for all classes a considerable increase in the consumption of milk and fresh vegetables is desirable. It is impossible for our own soil to provide all the food required, and we thus have the advantage of being able to concentrate on produce for which our conditions are best suited, or for which there is special need. Conditions of climate and soil eminently fit the greater part of Britain for a pastoral type of farming.

These facts obviously point the way to a great development of dairying, which, in the pre-war years, had already become the most

important single branch of British farming. Probably, however, further development must take place along different lines from those of the past 20 or 30 years, when milk production, particularly in winter, became largely a process of converting cheap imported foods. In future, we may expect that our dairy farmers will have to be more self-supporting and to maintain their herds to a greater extent on the produce of their own land. This will probably involve the substitution of rotational grass for a good deal of permanent pasture, and the use of the arable part of the rotation for the production of winter feed for the herd.

Similarly, an increase in the production of fresh vegetables fits in both with a sound nutrition policy and with developments in agriculture which would be comparatively easily made. At the same time, a word of warning is necessary to those who look to the growth of vegetables to solve the problems of the arable farmer. Unless the tastes of our people can be more rapidly altered than seems likely at present, a comparatively small area of additional land devoted to vegetables would satisfy all probable requirements.

2. The land is one of our greatest possessions. We ought to preserve it from neglect and deterioration, whilst using it to make its maximum contribution to the national welfare. Fortunately, unlike many other resources, e.g., mineral wealth, it gains rather than loses by proper exploitation. It will be generally agreed that, taking the country as a whole, there has been for many years deterioration in the condition of the land and in buildings, drains, fences, etc. Worst of all, in many districts, particularly those of low fertility and remote situation, the population has become dispirited. It often consists very largely of elderly people, the younger generation having left for more remunerative work and more congenial surroundings.

A bold policy designed to put new life into the countryside is required. The Government, through the Agricultural Executive Committees, is already doing something by taking in hand derelict or semi-derelict farms, carrying out drainage schemes, etc., but their efforts are strictly limited by war-time needs and difficulties. Most of the work needed must wait until after the war. An essential preliminary to real reconditioning in many districts, particularly where the land is of marginal character, is the reorganisation of the whole layout of the countryside. A large proportion of farms are of uneconomic size and plan having regard to present-day conditions and to recent developments in agriculture, of which perhaps the most important is the introduction of the tractor and the machinery associated with it.

This is not to say that all small farms should disappear or

that even the majority of farms should be very large. For dairying or stock rearing, a medium-sized farm has many advantages, whilst, under certain conditions, smallholdings have still an important part to play.

Whether a complete overhauling of the land and its equipment will involve full nationalisation of the land cannot be considered here. It is certain that the State will, in some way, have to assume responsibility for it. There are now few landowners able to undertake such work on the required scale. Moreover the rights of owner-occupiers and of sitting tenants would make it practically impossible to carry out readjustments of boundaries on a voluntary basis.

3. For full utilisation of the land, we need a larger rural population than we now have. At the same time a reasonably prosperous and contented rural population contributes such valuable qualities to the national stock that, for this, as well as for the sake of the land itself, special efforts to increase the numbers of those directly connected with the land are justified. Such efforts will only be successful if remuneration and living conditions in the country are comparable with those of workers in other industries.

So far, efforts to bring about such a state of affairs have not been very successful, even in countries where agriculture is of far greater relative importance than it is here. In this country, the first reactions to the warnings given by the Minister of Agriculture when he announced the new national minimum wage, show that the principle will not be conceded by commercial interests without a keen struggle. The fixing of prices at a satisfactory level and the provision of assured outlets for his produce are what the farmer would most desire, but it may be that for a long time to come the indirect method of subsidies may have to be continued. The need for these will be greatest in the arable districts of the East and South, where corn growing is naturally a most important feature of the farming, and the full blast of overseas competition is felt. Among the most difficult of post-war decisions will be those relating to wheat and sugar beet.

The full utilisation of our land implies that due consideration will be given to the poor as well as the good farms; to upland as well as to lowland. This, in turn, involves the safeguarding of our meat industry in view of the area of land which is restricted by its nature and situation to sheep farming and the rearing of store cattle. Unlike some continental countries, we cannot restrict our cattle husbandry entirely to milk production.

4. The State cannot be expected to assume the responsibilities indicated in 1, 2 and 3 without a substantial return from the farmer. If the State reconditions the land, it is entitled to insist

that farmers shall cultivate it properly and in accordance with the national policy. If they are to be given an assured market at remunerative prices, they must be prepared to produce what the State requires.

Finally, one other matter must be mentioned, though it is of more than purely agricultural concern. To a future historian, looking back on the period between the two wars, one of the strangest facts will be the vast sums paid out in unemployment benefit when the land—one of the nation's most precious assets—was deteriorating at a disastrous rate, mainly because of failure to put labour into it. Is it too much to hope that such a state of affairs will not recur and that, in future, no able-bodied man will be unemployed for any length of time, so long as there is land to be drained, limed and reclaimed; better roads and means of transport to be provided; farm buildings to be adapted to suit modern conditions of farming; and farmhouses and cottages to be built or restored and equipped with modern conveniences?

T. G. WILSON, M.A., Carbeth, Balfron.

The development of commerce and industry has brought prosperity to many, but the cost has not been counted. Only now are people beginning to realise that cheap food for the masses is bought too dearly if it involves the impoverishment of the land and the ruination of country life.

It is not merely as a useful form of insurance in times of emergency that the case for a prosperous agriculture is founded. The whole physical and spiritual health of the nation requires that the excessive swing from a predominantly agricultural to an intensely industrialised community shall be arrested and a better balance restored. The nation can only neglect the land at its own peril and State policy must be directed to preventing the rot setting in again.

A large measure of agreement could be reached on general principles. For example, fine agricultural land should be saved from destruction by building development; the poorer and marginal lands should be brought into proper condition for the production of food, and what cannot be so used, for timber. In short, the use to which land is to be put should not be determined by temporary economic factors or by sectional interests or individual taste, but should be controlled by the nation for the nation. Similarly, there will be general agreement that agricultural policy must be dictated by the overriding necessity to maintain the fertility of our good lands and to improve the poor. Those who work on the land, too, must be afforded conditions of labour—wages, housing and recreational facilities—at least as good as those of urban workers.

Indeed, it would not be difficult to proclaim a Rural Charter to which men of every class and political complexion would readily ascribe. The difficulty arises when the attempt is made to translate good intentions into practical measures. It is then that differences of opinion and conflicting interests appear, and there is the danger of history repeating itself after this war, of the good intentions being forgotten and the practical measures abandoned.

One common denominator can, however, be found amid all the diversity of opinion, and that is the necessity for control or, to use a more fashionable word, planning. The policy of *laissez-faire* which led to the decay of agriculture has gone for good; so also, it is to be hoped, have the spasmodic, disjointed attempts to provide Government assistance to agriculture. Sudden and expensive injections of dope may avert the collapse of this or that organ of the body, but they contribute nothing, and, indeed, often bring harm, to general health.

Control is not new nor has it always been successful. But failure has been more often due to the fact that control did not go far enough than that it went too far. How far it should go after the war is a highly contentious subject, but probably all political parties and certainly many agriculturalists are prepared for wider control than before the war.

The control of one commodity involves the control of others; if beef production is at the mercy of every form of foreign competition, repercussions in other branches such as milk, which enjoys a certain measure of natural protection, are inevitable. The marketing of home produce cannot be divorced from imported supplies. If farm workers' wages and conditions of employment are subject to regulation, then the farmer must be put in a position to pay them. In return for guaranteed prices to producers the public will naturally demand the assurance that the land is being efficiently and properly worked. And so on; one thing inevitably leads to another. But there is no reason why it should lead to "farming from Whitehall." The Agricultural Executive Committees point the way to highly skilled local direction by respected and capable practical men.

It is sometimes assumed that the only person to gain by the fixing of producers' prices is the producer. Certainly, if this is the result, the policy will defeat its own object, which is to do justice to the people as a whole and to enable the farmer to do justice to the land.

What the farmer needs is the confidence and stability over a term of years which will enable him to plan rotations and farm his land in the way most suited to the climate and soil. He cannot expect to be set up on a pedestal of profits. What the consumer needs is good wholesome food at prices he can afford to pay.

Part must come from abroad and part must be produced at home; the business of control is to share out the market between home and imported supplies, allotting to each the part it is most suited to play.

If the State is the sole purchaser of home produce, then it can dispose of it as it likes. By price management it can encourage both the production and consumption of those commodities most required in the public interest. Moreover, if a prosperous industry provides a market for the products of agriculture, a prosperous agriculture would also provide a valuable home market for trade and industry.

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Consideration of the events which followed the last Great War should convince anyone who is sceptical of the wisdom of post-war planning, before this war is over and won, that such planning is not only wise, but is really necessary. The national energies which are now directed towards preserving our very existence should, immediately the war is over, be diverted to a prepared plan of reconstruction, so avoiding the chaos and neurotic reaction which followed the last war with such disastrous results.

Any plan of reconstruction for agriculture must be such that, while it is wide in its scope and far reaching in its effects, it should command the support of the great majority of the people. Any plan confined to the interest and welfare of the rural population alone is bound to fail. The plan must be on broad, comprehensive and daring lines.

Land Ownership.—The first point to consider is the land itself, a national asset at present mainly owned by private individuals who, for a variety of reasons, including crushing taxation, are not even now able to manage their estates efficiently, far less to take part in a national scheme of reconstruction for British farming and rural life.

It is essential to any large-scale plan that has any hope of getting the necessary support from the people of this country and of being a success that the land should pass, gradually perhaps, but nevertheless surely, into the ownership of the State. Even awareness of the difficulties of administration under a scheme of State ownership can't alter such an opinion.

Land Tenure.—The land should continue to be farmed by tenants who would enjoy security of tenure for themselves and their descendants, provided they farmed according to the laws of good husbandry, and subject to the general needs of the State.

Types of Farming.—By reason of the contour of the land, the extent of its area and the climatic conditions which prevail,

this country is best suited to stock raising (sheep, cattle, poultry and pigs), dairying and market gardening, and these must continue to form the basis of its agriculture.

Cropping, particularly grain growing, apart from the needs of the farm, should mainly be confined to areas which can best be adapted to large-scale mechanised farming. In this connection it will be necessary to make the fullest use of both existing and potential methods, and for such developments many farms should be grouped and replanned, which would be difficult, if not impossible, under private ownership of the land. These methods, resulting in a large displacement of labour, should make it possible to produce wheat and other cereal crops that would compete in a free market with imported cereals. The problem of paying agricultural wages bearing reasonable similarity to those paid in other industries will be practically solved under this system of farming.

Stock farming will continue to be the bulwark of our agriculture, and here the possibilities of labour saving by means of mechanisation are more restricted. Considerations of the incidence of disease and output in small and large units of stock dictate that, while some enlargements of units may take place, the prospects in this direction are limited.

On the whole, then, Britain will continue to be a land of fairly small farming units, employing a relatively large number of workers, making use on a limited scale only of the products of modern engineering.

Labour.—Farm workers are entitled to be counted among the country's most skilled artisans and, as such, should be recompensed on a fitting scale. If proper comparative value is placed on the perquisites which form part of farm workers' remuneration, the recent rise in their cash wage brings them into more reasonable line with workers in other industries than has ever been the case before. This position must be maintained and possibly improved under a post-war policy plan.

Housing.—Rural housing has been greatly improved in some areas, but, as yet, only the fringe of the problem has been touched. There is room for a great rural housing drive and, while tied houses will continue to be a necessary feature, especially on stock and dairy farms, there should be a development in the direction of housing farm workers in villages and in groups of council houses built in farming areas. Rural housing will be influenced by national schemes involving extensive improvements in the distribution of water, electricity, transport facilities, rural villages and industrial dispersal.

Government Assistance and Control.—The greater part of the farming industry cannot be developed and maintained without State aid, and this is not likely to be given without some form

of control. It will be necessary to see that farmers conduct their business on proper lines and farm efficiently, and it may even be necessary to see that they produce what the country most requires. This can best be done by the retention, possibly in a modified form, of the Agricultural Executive Committees which are at present doing such good work.

In the past the people of these islands have enjoyed cheap food, some of which has come from countries where the general standard of living was lower than our own, and much of which has been produced by our own farmers and farm workers at the expense of their own standard of living. It is only right that a proper balance should be struck between the standard of living of the rural and urban workers, even if it is necessary to reduce the one in order to raise the other, but, on the whole, it will be easier to achieve this by indirect payment rather than by a direct rise in the price of food. In the future some form of Government Controlled Imports Board should regulate the flow of imported foods into this country, which, after due regard to our trade agreements, should be bought in the cheapest markets.

Our own produce should be purchased by a Government organisation, such as the present Ministry of Food, at prices which will meet cost and return to the farmers and farm workers a reasonable recompense. The same organisation would buy the food which the Imports Control Board allowed into this country.

It is to be hoped that the people of this country will take an intelligent and far-seeing interest in any post-war plan introduced for the development of our agriculture and rural life.

HUMUS AND SOIL FERTILITY.

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Considerations of national security have obliged us to expand our production of food crops—grain, potatoes, sugar beet and vegetables—and hence to reduce our area of grassland. This reduction in pasturage has coincided with a great fall in our imports of animal feeding-stuffs, and the double shortage has necessitated considerable reductions in the numbers of certain classes of livestock. We thus find ourselves with increased acreages of arable crops and with reduced supplies of dung. Moreover the available dung, because of the reduced cake rations of the animals that produce it, is often below normal quality. There is thus an obvious risk that the disturbance of the old balance of our farming may lead to serious impoverishment of our soil.

It is well known that crops such as wheat and potatoes, when they are sold off the farm, carry away substantial amounts of plant nutrients—of nitrogen and phosphate in all cases, and sometimes of potash as well. On the other hand when turnips, oats and hay are fed to livestock on the farm, and when care is taken to conserve the manure, the bulk of the nitrogen and phosphate, and a still larger proportion of the potash, go back to the soil. The loss is indeed relatively high when the animal is a dairy cow; it is lowest in the case of a fattening bullock. Thus the selling of crops ordinarily necessitates heavy purchases of artificials, while meat production does not. It is generally agreed that one of the chief needs of our war-time industry is the greater use of artificials, and every effort is being made to secure increased supplies.

The second question is whether, or how far, our soils will become impoverished even if we can make good the increased drain of plant nutrients. In other words, what is the importance of organic manures as such, or of the soil humus that they produce, in the maintenance of crop yields and the quality of crop produce? This question has lately been argued with a great deal of heat. A number of recent books[1] put forward the view that organic remains in the form of dung, compost, turf, etc., form the only real basis of fertility; that organic manures are necessary to the "life" and "health" of the soil; that only a living and healthy soil can produce healthy crops; and that foods derived from healthy plants are in turn essential to the health of man and

[1] See, for example, Sir A. Howard: *An Agricultural Testament*; Lord Northbourne: *Look to the Land*; C. H. Warren: *Corn Country*; Lord Lymington: *Famine in England.*

beast. The thesis, in its most extreme form, suggests that we can cure all the ills that flesh is heir to by the full and proper utilisation, as manure, of organic waste. There is some slight difference of opinion among different exponents about the value of artificial fertilisers. The best that is said of them is that they are stimulants rather than fertilisers; at the worst they are regarded as no more than a means towards the speediest possible robbery of the soil. These views, it may be said, are in no case supported by concrete evidence that could be expected to convince an ordinarily reasonable man.

By a coincidence, too, the views of the "humus school" have been urged at the same time as an entirely conflicting set of notions about the growth of plants. The new science and art of "Hydroponics" is a system of growing plants not only without humus but without soil of any kind. Its exponents suggest that better and healthier crops can be produced by providing an anchorage of gravel or netting, and by feeding the plants on simple chemical salts dissolved in water. Indeed it is no new discovery that plants can be grown very well in this way. Water cultures have long been widely used in laboratories for experimental purposes.

It is, of course, impossible to deny that humus has important uses in ordinary field or garden soils, and, if we give free rein to our fancy, we can imagine many explanations of its value. Humus is a complicated mixture of complex substances, and its composition continually changes as it decays. Its chemistry, and that of the changes that it undergoes, are not known in any detail. But certain of its properties seem to be of little interest to the farmer, whereas one or two of its characteristics seem to provide a fairly simple explanation of its practical effects.

One point that is strongly urged by the "humus school" is that the addition of organic remains promotes the life of the soil. This, of course, is true. Fresh organic matter provides food for vast numbers of living organisms—bacteria, moulds, protozoa, insects and worms. Some of these are harmful, some useful, and most have no known effects upon plant growth. Broadly speaking, of course, these organisms break down complex organic substances into simple salts, like nitrates and phosphates, which the higher plants can absorb. But we must not forget that apparently normal and healthy plants can be grown in soil that has been so treated as to kill the whole of the living things that it contains, and then supplied with chemical nutrients. So far as is known only a limited number of plants, such as clovers and heaths, depend directly on other living organisms for their full and healthy growth. Again, organic manures often contain "growth substances" or "plant auxins" and these can influence

the form of plant growth; but it has not yet been shown that they ever really benefit crops growing under ordinary field conditions.

So long as we are thinking of humus in the proper sense of the word—i.e., of organic matter that has passed through the early and more rapid stages of normal decay—it seems that its physical nature, rather than its chemical composition or the living things that it feeds, is what really matters. Humus is in an extremely fine state of division. A given volume has an enormous internal surface. Now the water in a soil, unless there is actual water-logging, is present in the form of a film on the surface of the particles. The smaller the soil particles the greater will be the area of surface, and hence the larger the amount of water that the soil will hold against the force of gravity. Coarse gravel can hold little water, coarse sand a little more. Humus and clay, being very finely divided, can hold a great deal. Moreover, humus, like clay, is partly in what is called the colloid condition. This condition is intermediate between the solid and the solution; the particles have no clear-cut edges, but shade off into the surrounding water. Soil and water are thus in rather firm combination.

Colloids have the further property of being able to absorb and hold certain soluble substances like ammonia and potash, and to give these back into the surrounding water solution when this becomes weak. Nitrates do not form these combinations with colloidal humus or clay and hence, as is well known, they are much more easily washed down to the drains than ammonia or potash. But the presence of colloids does probably help to reduce the loss of nitrates. This is because the colloid acts as a kind of cement, holding the mineral particles of the soil together in crumbs. If the soil has a good crumb structure, rain tends to run down the interspaces instead of soaking through the whole mass. The proper crumb structure, of course, has to be produced by frost and suitable tillage; but it cannot be produced or held in the absence of cementing material. Clay and humus are alike in their capacity to absorb and hold both water and manurial substances. They differ from sand and gravel in these respects.

Humus differs from clay in being much less sticky when wet, and in forming a much weaker cement when it is dried. It thus has the same uses as clay without the practical disadvantages of the latter.

If we are right in supposing that these physical properties are what matter, then we should expect humus to have a marked effect on the fertility of a sandy or gravelly soil, but much less influence on that of a strong clay. On clay soils, as the humus content falls, we should expect no more serious consequence than a slowly increasing difficulty in making a tilth.

Oldershaw[1] has recently published the results of a rotation experiment which has completed its fortieth year, and which brings out clearly the effects of withholding organic manures from poor, heavy clay soil. The experiment station is in the dry county of Suffolk, but an examination of the weather records and yields shows that wheat and beans do not suffer from drought, and that barley suffers only in quite exceptionally dry summers. Generally speaking the yields of these crops are better in the drier seasons. Of the crops grown the only one that is markedly dependent on summer rain is the aftermath clover.

The land is run on a four-course rotation of wheat, mangolds, barley, and either beans or red clover. The last crop is mown twice in the season for hay, so that all the crops are removed from the land. There are ten plots in all, but only three need here be considered. One of these has received neither dung nor artificial during the forty years. A second has had an annual dressing (i.e., to every crop) of six tons per acre of court-fed dung of fair average quality; this amount, 24 tons per acre in the four years of the rotation, is something like twice that which would be available in ordinary practice. A third plot has had an annual dressing of 5 cwt. of artificials per acre—2 cwt. superphosphate, 2 cwt. nitrate of soda, and 1 cwt. muriate of potash. The average yields for the first and last periods of the experiment are given below.

		1900-1908	*1929-1940*
Wheat (bushels)	No manure - -	29·0	18·1
	Dung - - -	36·3	36·3
	Artificials - -	37·6	35·7
Mangolds (tons and cwt.)	No manure - -	6– 2	2–12
	Dung - - -	16– 8	16– 8
	Artificials - -	17–12	14– 6
Barley (bushels)	No manure - -	24·4	13·9
	Dung - - -	31·2	31·6
	Artificials - -	35·9	34·9
		1908-18	*1935-39*
Beans (bushels)	No manure - -	19·6	16·1
	Dung - - -	38·3	35·9
	Artificials - -	35·9	34·9
		1902-21	*1922-40*
Clover (two cuts per year, cwt.)	No manure - -	28	36
	Dung - - -	62	90
	Artificials - -	53	73

[1] "Experiments on Arable Crops at Saxmundham." *Journal Royal Agricultural Society of England*, Vol. 102, 1941.

It will be noted that the artificials produced a slightly higher yield of wheat in the early years, but that the advantage was not maintained in the last period. Barley yields were higher with the artificial fertilisers, but rather less markedly so at the end than at the beginning. Dung had a slight advantage for beans. Broadly speaking, however, these three crops seem to be rather indifferent to organic manures under the soil and climatic conditions at Saxmundham. Artificials showed up well with mangolds in the first nine years, but, whereas the yield on the dunged plot was maintained, that produced with artificials fell by nearly twenty per cent. between the first and last periods. This may probably be put down to the growing difficulty in securing a good mould at seed time. Oldershaw in fact notes that the soil of the dunged plot is now more friable than that of the others. Perhaps the most interesting feature of the results is the marked superiority of dung in the case of red clover. The special effect of dung on this plant has been remarked by others, but, so far as the writer knows, no convincing explanation has yet been suggested. As regards diseases and pests, Oldershaw notes that the dunged mangolds have sometimes suffered more from insect damage than those on the other plots. He adds: " The plots afford no support to the theory that animal and vegetable manures prevent disease."

These findings are in general agreement with the still longer-continued experiments at Rothamsted, where the soil is of the same general type.

There seem to be no equally clear-cut experimental results for light soil in this country and indeed it would be difficult to plan an experiment like that described above which would be quite convincing; the effects of artificials on light and humus-deficient land depend on other factors than the quantity of plant food applied—e.g., on the lime status of the soil, the seasonal distribution of rainfall and the timing of the fertiliser applications. We are therefore driven back on the experience and observation of practical farmers.

One of the points on which there is very general agreement is that light land must be in good heart if it is to grow a satisfactory crop of wheat, and that artificials are no complete substitute for organic manures. In the case of extremely light chalk soils of the Yorkshire Wolds, for instance, the regular custom has been to graze the clover of the four-course rotation with sheep, to apply the dung to the clover land in the late summer, and then to plough and sow wheat.

The failure of wheat on light, humus-deficient land can hardly

be a question of moisture supply, for it happens in wet years more markedly than in dry ones, and the crop rarely "burns." A much more probable explanation is that the soil fails to supply the wheat with nitrate over the long period during which a supply of nitrate is needed. Of course, if the soil has recently been dunged, or if it has grown clover in the previous year, the organic matter will break down gradually during the spring and summer, and nitrate will be set free in a steady stream. Again, if the soil contains no fresh organic residues, but has a fair humus content and a certain amount of crumb structure, then a spring application of artificial nitrogen will be absorbed and partly held until it is needed by the crop. In the absence of humus an early spring application of nitrogen will either be washed into the drains or else quickly used up, leaving the wheat starving at the time when it should be filling the ear. This explanation is supported by the beneficial effects that usually follow the dividing of the top-dressing into two parts, giving half in early spring and the remainder about the end of May. This should be a regular practice for wheat growing on light land that is not in the best of heart. The plan does not, of course, guard against the risk that the nitrates will be washed down the drains by heavy summer rains. When heavy rains occur soon after the second top dressing it may be well to write off the latter as lost and dress a third time.

Whether the whole problem can thus be explained in terms of nitrogen supply is, however, doubtful. We must bear in mind the widespread opinion that beans on light land benefit from dung, and that this crop generally gives only a small response to nitrogen manures.

The behaviour of other crops on light and humus-deficient land is fairly consistent with the idea that the lack of a regular and sufficient moisture supply is the main trouble. Oats and turnips do well enough in dripping seasons, but suffer during quite short periods of drought; early sowing, enabling the plants to get their roots down before the onset of hot weather, is often a great help. Barley, with its lower moisture requirements, can often produce a useful yield on artificials alone. Potatoes may, of course, suffer from common scab and "sprain," a fact for which there is a special explanation. Otherwise a short period of drought is apt to give them the check that results in a good deal of "second growth" and in a poor yield. It follows that the maintenance of the humus content of light land is of special importance in dry and hot districts.

Supposing that the light-land farmer keeps all the winter stock that his circumstances will allow, and takes the best possible care

of the dung that is produced, what else can he do to keep up the humus supply?

It has sometimes been suggested that straw, instead of being trodden into manure, could be chaffed, spread on the surface of the land, ploughed in and left to form humus in the soil. Experiments on these lines are being carried out at Rothamsted and in Norfolk, but so far with no very satisfactory results. The main difficulty is that the soil organisms which break down straw into humus take up a lot of nitrogen in the process, with the result that the growing crop is starved. Attempts are being made to balance this shortage by putting on extra nitrogen artificials, but it seems to be difficult to keep the soil nitrate at the right level.

Probably the best of all methods of applying organic matter to the soil is to plough in a dense sward composed of a balanced mixture of grass and clover. The organic matter is partly living tissue and partly dead roots in various stages of decay, for grass roots have comparatively short lives and are constantly being replaced. The organic matter is thoroughly mixed with the soil, and so exerts its maximum influence The balance between grass and clover is important; as is well known, a very clovery sward has a high nitrogen content, like very rich cake-fed dung. It rots down very quickly and sets free too much nitrogen in the first season, with the consequence of laid crops. Its effect on the soil texture is naturally short-lived. A very grassy sward, especially if the grasses are of the poorer species like bent, behaves more like straw. It rots very slowly and may, in extreme cases, begin by taking up nitrate from the soil instead of supplying nitrate to it. If a well-spread-over effect is to be expected then something half-way between the two extremes is required.

To produce the dense and well-balanced sward that is needed we must sow a suitable grass seed mixture and supply phosphates. Neither the hay nor the lattermath must be left standing too late, and the management during the last year before ploughing must be calculated to keep the balance between the species. Heavy grazing in the early spring will suppress the early grasses and will tend to produce too clovery a sward. Conversely, light spring grazing, or the taking of a cut for silage or hay, will encourage grass and reduce clover. Finally, we should note that the establishment of a good sward itself depends to some extent on the humus content of the soil, and hence the intervals between successive leys should not be too long.

It is, of course, impossible to say, except from an intimate knowledge of the particular piece of land concerned, how far we can swing the balance from grass to arable, and from livestock

production to the sale of crop produce, without getting the land out of heart. But let us take an example. A farm of light loam has been worked on the "easy sixes"—three years grass followed by grain, roots and grain—with little expenditure on artificials except slag or mineral phosphate and lime. By using more phosphate and substantially more nitrogen, and with perhaps some extra care in the management of the ley, it should be quite possible to maintain fertility on a course of two years ley followed by four years under the plough.

HOME-GROWN AGRICULTURAL SEEDS.

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"BRITANNIA'S bulwarks" benefit her in more than the one obvious way. Insularity has made us largely self-supporting in agricultural seeds—and well may we be thankful for it. The *essentials* under our normal system of farming are two cereals: wheat and oats; two roots: turnip and mangel; two grasses: perennial and Italian ryegrasses; and two clovers: red and white. It is true we have developed, during the last couple of centuries, rather luxurious habits; we expect to be able to pick and choose among a lengthy list of species. It is not wholly a bad thing that war forces us to confine ourselves to essentials; not all our recent tendencies in cropping are good, and certainly not all our commercial tendencies.

We are capable of producing for ourselves seed of all the essentials mentioned and in recent decades we have in fact normally produced the major part of our supplies. Under present conditions we are faced with the problem, not only of supporting ourselves in this matter, but of filling a materially increased annual demand. Normal foreign supplies have been completely cut off in a number of cases, such as that of Italian ryegrass, of which in recent decades we have imported about a third of our requirement from Denmark. A certain small amount is available from New Zealand, but New Zealand is a long way off; certain other substitutes such as Oregon ryegrass are to be avoided. Fortunately we easily can, if we will, increase our own production to the required amount. But the "required amount" has itself risen materially. War has obliged us to plough already very large areas of our grassland and this has two repercussions. Land ploughed out of ley, in alternate husbandry, must be sown down again either immediately or after a short or long rotation. Augmented supplies of corn and root seeds are obviously called

for while the land remains "up," and additional grass and clover seeds are demanded before it can go "down" again. Moreover our tillage policy rightly envisages, for several reasons, shorter leys than have been popular and the shorter the ley the higher the annual requirement of forage crop seeds.

Our Dominions are giving us all the help they can and the United States of America has turned up trumps with her generous Lend-Lease scheme, but every hundredweight of seed brought across the sea uses shipping urgently needed for other purposes, and risks lives. So it is up to us to produce our own seed to the greatest practicable extent, and that we can produce it, in the case of the essential species, to a very large extent, there is no question.

Soil and Climate.—The average climatic conditions of the British Isles are admittedly not excellent for seed production—not so much by reason of rainfall as because of variability and unreliability at given seasons. Broadly speaking, it is evident that seed crops require "dropping" weather during the growing season, and fine, bright, sunny conditions for ripening and for that mysterious "after-ripening" which is as necessary to good germination as is fertilisation. But it is to be observed that the species and types of crop plant normally used here are normally used because they best suit our conditions, and it is therefore reasonable that we should be able to harvest them for seed if we can harvest anything. Here arises a notable distinction between cereals on the one hand and root crops and forage crops on the other. Our ordinary use of cereals *is* for the production of seed. From the varieties we normally use, therefore, we can obviously produce sound seed without difficulty in any reasonable season. But roots, grasses and clovers we ordinarily grow for their vegetative parts, so that "suitability" has not meant the same thing as in wheat or oats, and has not automatically confined our sorts and varieties to those which enjoy seeding in these islands. Hence we must select our areas and districts for these more carefully than for cereals when ripe seed production is in question. In past practice more or less clearly defined regions have become associated with particular crops or groups of crops for seed purposes, as, for example, ryegrass and oats in the southern half of Scotland and Northern Ireland, barley in south-east Scotland and East Anglia, or red clover in the south-eastern and southern English counties. But latterly it has been made clear that this segregation is not a necessity and that grasses, for instance, can quite well be harvested in Hereford or wild white clover, usually associated with Kentish and Cotswold pastures, in County Down or Roxburgh. Thus mere lack of tradition or of experience should not be a deterrent to the attempt. At the

same time any temptation to essay a seed crop simply because prices are good must be resisted; as also the inclination to select for trial the crop which looks most profitable from the money point of view, unless it is also the most suitable from the standpoint of agricultural conditions; nor, of course, does it follow that the crop yielding the highest gross return per acre will furnish the most profit. Thought should be given, first, to the kind of season to be expected and, second, to the availability of labour (for it cannot be pretended that seed crops are inexpensive in labour) and, third, but in less measure, to soil. An approximate estimate of relative requirements in these directions is attempted in the table below :—

TABLE I.

Average requirements for seed crops, compared with oats as standard.

Class	Rain	Sun	Labour	Sweet Soil
Oats -	xxx	x	x	x
Grasses -	xxx	x	x	x
Clovers -	xx	xx	xx	xx
Roots -	x	xxx	xxx	xx

N.B.—" x " is not intended to have any definite quantitative value.

In regard to rain and sun the most important factor is distribution through the season. Sun is, of course, needed for satisfactory ripening in all cases, but ripening is a " movable feast," so that where July sun will ripen winter oats, red clover may call for a sunny September, and so on

Clovers.—In the south the early growth of *broad* red and wild white is *not* used for seed It is eaten down or mown and rain is then needed about midsummer to encourage new growth. It follows that dry, fine weather is required for pollination a month later and a sunny spell about a month later again for harvesting The position is changed in the case of late-flowering red (" single cut ") since it does not produce a material second crop; but as it is about a fortnight later than broad red in flowering only a small shifting of the moist and fine spells is needed for optimum conditions. Wild white being usually harvested from pastures has rather more exacting rainfall requirements than the reds which are mostly grown pure if intended for seed. Relatively little rain at the wrong time can indirectly spoil the wild white crop by encouraging a heavy second growth of grass which bears down the short clover heads to the ground where they lie wet and smothered and eventually decay. Even if red clover is mixed with ryegrass its greater stature tends to protect it against this difficulty.

True clovers (genus *Trifolium*) are not so very insistent on thoroughly sweet soil as their cousins the medicks (lucerne and trefoil) and chalk-loving relatives such as sainfoin and kidney vetch. They do, however, prefer a sweet soil and must be well provided with phosphate.

Grasses.—Generally speaking, grasses enjoy moister conditions than clovers and succeed the better in the north and west. Spring or summer rainfall (according to time of sowing) ensures a good strike which, in addition to being in itself a prime factor for a successful crop, helps very materially in keeping weeds in check, especially if, as is common with ryegrasses, the sowing is broadcast. An annual rainfall of some 40 inches does not preclude seed production with ryegrasses or cocksfoot if reasonable weather for harvest can be seized upon. The larger grasses respond strongly to richness of soil and in most areas also to additional treatment with artificials. This applies to cocksfoot even more than to ryegrass as a seed crop; timothy likes moist, strong conditions as in peat soils and in carse land. The facility with which tall-growing grasses can be bound in sheaves gives them an advantage over clovers under inclement weather conditions; they can be stooked, and, when opportunity serves, built into huts (pikes, rickles, trampquoils) with heads inward, in which state they will stand a good deal of rain without serious harm, or they may even be carted and restooked under an open hay barn if conditions are desperate.

Roots.—The freer soils are usually associated with seed production of " bulbing " root crops, probably less on account of actual preference on the part of the plant than because early ripening is encouraged. Fertility is called for and an adequate supply of phosphate. The worst climatic enemy of cruciferous seed crops (turnips, cabbage, rape, kale, etc.) is wind (or heavy rain) at ripening. To an extent, these crops will finish ripening their seed on the straw after cutting, but, when properly ripened, they " shatter " (shed their seed) with extreme ease. This necessitates the greatest care in handling during the whole harvesting process and if really bad weather supervenes at harvest time a whole crop may be lost in a few hours. Roots are not to be recommended in areas where harvest weather is uncertain and unless in favoured spots are probably not the best choice for seed production in Scotland.

Cultural Principles. *Sowing.*—Herbage crops like a fine, firm seed bed and shallow sowing. They are better sown in drills than broadcast (though the larger grasses are commonly broadcast in the United Kingdom). Drilling takes less seed per acre—a consideration when seed is scarce and prices high—and permits inter-drill cultivation and weed destruction besides giving, under fertile conditions, a higher yield than a broadcast crop. Broadcasting is, however, the standard practice for ryegrasses and is preferable

where the seed crop is part of the ordinary rotation and represents the first year of the grass term, as in the case of perennial, where a mixture of cocksfoot, timothy and wild white clover is added to the ryegrass to ensure a good grazing sole in later years. (Italian being short-lived cannot be treated in this way, but is sown alone and ploughed up after harvesting.) If broadcasting is adopted a fiddle and *care* should be used to ensure even sowing. A windy day is naturally to be avoided. If a mixture of grasses and clovers is being broadcast it is a useful practice to sow the large seeds (ryegrasses and cocksfoot) first and the smaller grasses and clovers at a second application, since the latter need to be sown shallower than the former and may simply be rolled in, the larger seeds having been lightly harrowed. Clovers are generally drilled and the larger kinds are usually sown pure if intended for seed, though they can be harvested from a mixture with ryegrass. Wild white is commonly harvested from pasture after some years' grazing but can be sown pure and harvested as "once grown" produce, which is perfectly satisfactory from an agricultural point of view and, of course, yields a much heavier crop of seed per acre than the pasture.

The question of sowing herbage species with a nurse crop (cereal or rape) depends on several factors, the chief of which is rainfall at sowing time and consequent probability of a good strike. It is seldom that a late summer sowing (July or August) really needs a nurse, though for other reasons (e.g., stock-feed) it may be convenient to sow under rape. In spring sowings a cereal nurse is generally used, commonly oats or barley.

Root crops are, of course, drilled (or planted out in rows in such cases as cabbage, etc.) either on the flat or on ridges. They are usually treated as biennials, but can be grown as annuals if sown in autumn. In the former case the "roots" are lifted in autumn, stored over winter, and planted out again in spring to run up to seed. This practice permits the selection of good, well-shaped roots for seed production and the elimination of coarse or poor or fangy specimens.

Isolation.—In cruciferous root crops, cross fertilisation is particularly easy and particularly undesirable. The well-known useless "bastard" roots are the result of it. Turnip, swede, cabbage, etc., crops for seed must therefore be well isolated—by a distance of say a quarter-mile—from other cruciferous crops of similar type. The cabbage type does not, however, readily inter-cross with the turnip type. With grasses and clovers the matter is of less importance except where special strains are being used.

Cultivation.—In the case of herbage crops the chief cultivation implements are grazing animals, harrows and mowers. The object

is to ensure an even start and steady growth to maturity of the maximum number of healthy flowering stems. The value of grazing in promoting strong tillering is well known and so, nowadays, is the invigorating effect upon foliage of the removal of "fog." A crop of healthy flower stems requires a crop of healthy leaves beforehand. Hence grazing animals are used in autumn or spring or both (a) to tread; (b) to manure; (c) to remove old herbage; (d) to level off the sward. If the last mentioned is not satisfactorily achieved by the spring grazing, a mower follows the beasts and polishes up the job. If there is little to mow, it may lie; if there is much, it should be raked off. The condition of the field when ready to "shut up" decides whether a brush over with a harrow is desirable; commonly it is—in order to distribute manure droppings. Rolling will suggest itself when it is called for.

The cultivation of "bulbs" of turnips, swedes or mangolds needs no elaboration here. These being secured, "cultivation" in the seed harvest year resolves itself into cleaning between the rows as for any arable crop, keeping it up as frequently and as long as circumstances will permit. The same applies to other fallow crop types if drilled or planted in rows—(as they should be). Such crops as rape are a temptation to broadcasting, but weeding is impossible in a broadcast crop, and undersowing with herbage species has its own obvious difficulties particularly at harvest, although it is sometimes done.

Manuring.—It is a better general proposition to grow seed crops on fertile ground than to force them by heavy manuring. Uniformity and stamina are jeopardised by the latter method. Adequate general manuring is therefore to be advised in the year preceding the seed harvest year—in the case of root crops in the *root*-growing year—with the use of stimulants, *only if they are needed*, in the harvest year. These are normally only wanted for grass crops.

Clovers call chiefly for phosphates, or phosphates and lime. These are slow acting; if lime is required it should be applied before sowing the crop and phosphates are best put on (in the form of slag if procurable) in autumn, after removal of the nurse crop. Failing this, superphosphate may be used in spring. The clover will have the benefit of animal droppings and will not require nitrogen. Potash manures are not available for herbage crops at present. There is, however, usually enough potash in all but the lightest soils for a grass or clover crop.

Grasses should have a general dressing at sowing unless the land is rich, and it is commonly desirable to give a fillip in spring by means of sulphate of ammonia, or better, nitro-chalk.

Root crops should have the usual dung and/or artificials in the

first year, with a nitrogenous stimulant to the braird, but overdosing with nitrogen must be avoided since it leads to bolting and the grower does not want his first-year crop half roots and half flowers.

Harvesting.—The trickiest harvesting problem is *when* to harvest; the rest is only a matter of care and weather. Clovers are generally not ripe for some time after they *appear* ripe. The flowers die and turn brown soon after the seed is fertilised—they have served their purpose; but the seeds are at this stage quite soft and green. The only satisfactory test of ripeness is to rub out in the hand a random selection of heads from different parts of the field and examine the seed itself. The object is to cut when the maximum proportion of the heads in the field are properly ripened—they will never all be just right at the same time. The grains should feel quite firm and "shotty" when the flower head is pinched between the fingers and should rub out of the heads fairly easily. Red clovers show a good proportion of purple-coloured grains at this stage; whites a high proportion of bright yellow. An ordinary mower is used for cutting and swath turning must be carefully performed by hand, with forks rather than rakes, to avoid shedding the seed. Rakes may have to be (carefully) used for wild white clover which is often too short for forking. The same care applies to carting and stacking; a rick-sheet spread in the bottom of the cart or wagon will retrieve seed shaken out in "carrying." Stacks should be small to avoid overheating and are often provided with special ventilation shafts or galleries by laying in bundles of sticks or pairs of hurdles as the stack rises, or by building it round a stuffed sack which is drawn up as stacking proceeds, thus leaving a vertical airshaft through the stack.

Grasses are on the whole less liable to "shatter" than ripe clovers, though careful handling is still desirable. Most of them can be cut with a binder if sufficient care is used in the operation and in the choice of the moment for cutting. As a rough rule grasses ripe for cutting still show a green shade in the chaff of the ear with the straw definitely yellowing for the first few inches below the head. With "spike" heads like timothy, the tip of the spike is beginning to lose a few "seeds." Open heads like ryegrass will release a few "seeds" if gently pressed in the hand without pulling. (Ayrshire growers expect perennial ryegrass and black currants to be ripe together.) Grass sheaves are tied and stooked for a few days and then built into "pikes" or "rickles" with the butts of the sheaves outward. Neither stook nor rickle should be too large—say, six sheaves for the one and 7-10 cwts. for the other. The rickles will stand (tied at the top and, if necessary, elsewhere) for a week or two before carting. Root and "green" crops are laborious to harvest. They ought to be cut by

hand, though under good conditions a mower *can* be used for a crop like rape if knives are kept sharp and if the grower is prepared for some loss. When ripe the haulm is yellowish and seed rubs out easily and is strongly coloured in species of the turnip and rape type; in mangel the "cluster" rubs off, but the seed does not rub out. Good growers often lay the sheaves down separately, unbound, for a few days in the sun before stooking. Stooks are carted to a covered shed where they are stacked loosely, with air passages, to await threshing.

Threshing.—The larger grasses and roots will thresh in an ordinary thresher with concave and screens properly adjusted. Special machines are built for clover; an ordinary mill *can* be used, but the produce usually needs to be put through a second time with a readjustment of the drum. If only small crops for home use are in question they may be threshed by flail or by beating handfuls over the rungs of a ladder—the difficulty then is that common farm equipment is not sufficient for thorough cleaning of the produce, though much can be done by the careful use of hand riddles and an ordinary winnower. It is important to thresh on a dry day.

Storage.—Any seed when freshly threshed should be spread in an airy, dry place (e.g., a clean loft) for a week or two until it has matured and dried out, before bagging. The layer should only be a matter of inches (6-8) deep and should be turned at intervals of, say, two days by shovels. After bagging, it should be kept cool and dry; *when properly mature* ventilation is not so important. Look out for rats and mice.

THE REVIVAL OF LIMING.

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For many years agricultural teachers and advisers have been extolling the virtues of lime and urging farmers to use it more extensively. Although there has been some response it has been small in relation to the need. Experiments and soil tests have shown that more than three-quarters of the arable and permanent pasture land in Scotland is deficient in lime, and it is estimated that, to satisfy the immediate needs, about a million tons of burnt lime, or double that amount of ground limestone, would have to be applied annually for the next four or five years.

In many districts, judging from the disused limekilns found throughout the country, liming was at one time much more general than it is to-day. The farmers in those days were not necessarily more intelligent than their successors, but many of them were dealing with recently reclaimed land which was often

sour and moorish and refused to grow crops until lime was applied. In those days, too, they had not the advantage of stimulants in the form of artificial nitrogenous fertilisers and the effect of applying lime was more obvious. The present-day farmer can obtain a more striking response from a dressing of, say, sulphate of ammonia, and is apt to forget that the use of artificials does not obviate the need for liming but increases it.

Bigger crops mean that more lime is being removed from the soil, and in some cases the fertiliser itself causes lime to be washed out in the drainage water.

The use of certain artificials without due attention to the lime reserves is harmful in most soils, but the effect is gradual and insidious. For long periods the farmer may draw on the reserves applied by his predecessors, who in many cases applied more lime than was necessary for immediate needs. The supply, however, eventually becomes depleted, but the falling off in yield is so gradual, especially with such crops as oats, potatoes and turnips, that the shortage of lime may be acute before it is noticed or, at any rate, before it is remedied.

Other factors have also contributed to the neglect of liming. Increased labour costs have made liming more expensive than it used to be, but the lime subsidy, one of the most beneficial agricultural measures in recent years, has done much to remedy this. In the interval, however, most of the local limekilns have gone out of use, and in many parts of the country lime has to be transported long distances. The fact that liming with quicklime is a disagreeable operation has also helped to deter farmers. Lack of capital is another factor, and in bad times liming has usually been regarded as an expenditure which could be avoided or at any rate postponed.

Does it pay to lime?—It is often asserted that farmers need no urging to adopt a policy or practice if they are convinced that it pays. In the case of liming, then, it would appear that many have not been convinced. One reason is that, in many instances, the response to liming is not spectacular. Increases of yield of, say, five to ten per cent. or even more may pass unnoticed, particularly if no unlimed area has been left for comparison. Pasture in particular benefits from liming, but it is not easy to measure the improvement. Many of the experiments on the effects of liming have been carried out for only one or two years, but the effects last much longer, and, to get a true picture of the beneficial effects, the crop yields should be measured for several years.

Experiments laid down in 1939 at three centres on land in arable rotation by A. B. Stewart of the Macaulay Institute may be quoted as illustrating results which have been obtained. The

initial pH values of the soils were 5·4, 5·7 and 5·6 respectively, and to bring them to a pH of about 6·2, dressings of lime equivalent to 20 to 25 cwt. per acre of calcium oxide were applied. They all received basal dressings of nitrogen, phosphate and potash—the requirements being estimated by preliminary analyses. The yields are expressed as cwt. per acre and refer to fresh weight of turnips (roots), dry weight of grain plus straw of the cereals, and dry weight of hay.

	Centre 1 (Aberdeenshire) Soil derived from drift over diorite			Centre 2 (Aberdeenshire) Soil derived from drift over gneiss			Centre 3 (Kincardineshire) Soil derived from drift over gneiss		
	1939 Turnips	1940 Barley	1941 Hay	1939 Turnips	1940 Barley	1941 Hay	1939 Turnips	1940 Oats	1941 Hay
No lime	313	40	34	311	47	35	212	48	41
Lime	349	57	42	350	61	46	215	54	50

It will be seen that in centres 1 and 2 liming brought about an increase in yield of turnips of 12 per cent., but in centre 3 there was no effect. The increased yield of barley, including straw, at centre 1 was 41 per cent. and at centre 2, 29 per cent. The oats, including straw, at centre 3 showed an increase of 14 per cent. The hay increases in the third season after the application of lime ranged from 21 to 30 per cent.

It is clear that at all these centres the returns over a period of three years paid for the lime and left a very substantial profit. The lime, too, is by no means exhausted in three years, and it can safely be assumed that there will be a marked improvement in the pasture. These farms are typical of much of the north-east of Scotland, and were not chosen as being by any means abnormally deficient in lime.

In addition to the increased yields obtained through liming, there is an improvement in quality and palatability. The presence of an adequate supply of calcium in the diet is necessary for all animals, but it is particularly important for young stock, dairy cows and ewes. On farms where the animals are not thriving as they might, farmers would do well to look into the possibility of lime deficiency in the soil.

Liming also helps to discourage certain weeds, and it is not generally realised how greatly crop yields may be reduced by weeds competing for water, food and light. Although the weeds are not killed by liming, conditions are made less favourable for some of them, and more favourable for the agricultural plants. The same applies to the organism which causes "finger-and-toe" in turnips. Liming brings about conditions less suitable for the spread of the disease. During the past summer the writer inspected

turnip fields on two farms on which there was not a sound bulb, and in both cases the soils were very acid and badly in need of lime.

On the other hand, an adequate supply of lime favours the organisms which break down organic matter and liberate plant food. It also assists in the proper utilisation of artificial fertilisers. On very acid soils, for instance, soluble phosphates tend to become converted into an insoluble and unavailable form. All the evidence, then, goes to show that it certainly pays the farmer to keep his soil well supplied with lime.

When should lime be applied?—One of the reasons why liming is not done more extensively is that farmers often find themselves too busy at the time they consider most appropriate.

It cannot be too strongly emphasised that lime may be applied usefully at practically any point in the rotation, provided it is not ploughed under in fields which are about to be laid down to pasture for a number of years or applied in large amounts before a potato crop. The application of lime immediately before a potato crop increases the risk of common scab.

Since liming improves the take of grass and clover seeds, it is desirable to apply the lime, if possible, some time before sowing out rather than to the new grass. Bearing these points in mind, farmers can do their liming during slack spells at any season of the year, for instance, on grassland during summer or on stubble. There is no harm in ploughing it under if it is not ploughed in too deeply, and if it is brought to the surface again soon by subsequent ploughing.

Can the methods of application be improved?—High labour costs make it necessary for farmers to consider improvements in the methods of application of lime. Lump or shell lime must be put out in heaps, slaked and then spread. Apart from the amount of labour involved, there is the difficulty of securing even distribution. The lime is apt to become pasty or lumpy and uneven spreading is common. It is not unusual to find potato scab on the spots where the lime heaps were put out though the remainder of the field is free from scab.

Most farmers, nowadays, prefer ground material which can be sown by a manure distributor, but even this involves a good deal of handling and carting. An improved method has been described recently in this Journal by Major James Keith.[1] A manure distributor is fitted with a drawbar to fix easily to the back of a motor waggon, and the hopper is enlarged to permit of easy emptying of the bags of lime. The wheels are fitted with sheet iron discs, and aprons are placed on the front and rear of the distributor to reduce blowing of the lime by wind. The waggon

[1] XXIII., 129 (1941).

delivering the lime can drive right into the field and thus save a great deal of unnecessary handling. Under favourable conditions 5 tons per hour have been applied in this way. This scheme is particularly suitable for grassland or stubble, but for ploughed or other soft land the distributor can be attached to a cart or trailer drawn by a tractor. If haulage contractors handling lime employed such trucks or trailers, the lime could be handled loose thus effecting an appreciable saving, as bags and bagging at the present time constitute a considerable part of the cost of liming materials.

What forms of lime can be used?—Practically all agricultural lime is applied in the form of oxide (burnt lime, either as shell or ground lime) or carbonate (ground limestone, ground chalk, shell sand, marl and by-product lime). Many farmers still believe that there is no virtue in any form of lime other than burnt lime. This is utterly wrong, for it has been definitely proved, time and again, by careful field experiments, that other forms of lime used in *equivalent* amounts give exactly the same result. Burning lime merely converts the carbonate into the oxide and when it is applied to the land the oxide changes, almost at once, back to the carbonate. The heat given off, on which stress is sometimes laid, is of no consequence, as the amounts applied are not, as a rule, great enough to produce any appreciable sterilising effect. It is quite another matter mixing a large amount of lime in a rubbish heap with a view to destroying weed seeds.

What, then, is the point in burning lime? There are two main reasons; one is to bring the material into a form which on slaking breaks down readily to a powder. Before the days of efficient grinding machinery this was probably a necessary procedure, but nowadays it is easy to grind the limestone. The other reason for burning limestone is to produce a more concentrated product and save transport costs. Burnt lime has about double the " strength " of ground limestone or other forms of carbonate, and hence only half the quantity is necessary. There is, therefore, some point in burning lime if the limestone and fuel are found in close proximity, and if the lime has to be transported long distances to the farms on which it is to be used. From the farmer's point of view, too, there is the advantage of having only half the quantity to handle.

There are corresponding and greater disadvantages however. Burnt lime is difficult to store and handle. In order to secure even distribution, it is now usually purchased in the form of ground lime and, if circumstances prevent its immediate application, the bags may burst and there is also the danger of fire. Sowing ground lime is disagreeable work and it is understandable that farm workers often object very strongly to extensive liming operations. A prominent farmer stated recently that he could cope with the

task of applying burnt lime to one or two fields, but that he would rather give up liming altogether than attempt it on a widespread scale. This particular farmer applies large quantities of lime every year in the form of carbonate (dried paperworks lime, ground limestone or chalk).

Prejudice, however, dies hard and many farmers refuse to use carbonate, but it is interesting to note that in the United States practically all the lime is applied as carbonate—chiefly ground limestone.

In this country, ground limestone is still too expensive and in many places it is dearer per unit than ground lime. This is due, in some cases, to transport costs, for double the quantity of ground limestone (compared with burnt lime) has to be used and, beyond a certain radius from the source of supply, transport costs become excessive. The remedy for this is, of course, to open up limestone deposits all over the country so that it will be unnecessary to convey the ground limestone long distances. Every endeavour should also be made to reduce cost of production by employing the most efficient and labour-saving types of plant.

The cost of grinding could also be reduced if less stress were laid on bringing all the material to a very fine powder. Undoubtedly very finely ground material is effective more quickly, but, on the other hand, it is washed out of the soil more readily. From the point of view of general utility, therefore, as well as cheapness it would be advantageous to use material half of which was finely ground and half less finely ground. Professor G. W. Robinson has suggested the adoption of a grade of ground limestone all passing the 20-mesh sieve, and having about 45 per cent. of material finer than 100 mesh. This is similar to the " Agricultural Ground Limestone " commonly used in America. It seems likely that, in time, ground limestone will become the most popular form in this country also if it is plentiful and cheap.

There are other forms of lime which can be used, for instance, ground chalk, shell sand, marl and by-product lime from certain industries. Chalk does not occur in Scotland, but at various places along the coast there are large deposits of shell sand. This has been shown to be very effective, but transport costs limit the radius over which it pays to use it. Shell sands also vary greatly in lime content and in fineness and these points have to be taken into account in deciding their value. The best deposits contain over 90 per cent. of carbonate of lime (= 50 per cent. CaO) and in average deposits the percentage ranges from 60 to 85 (= 34-48 per cent. CaO).

Marl deposits are rare, but where they occur there is no reason why they should not be used. Their moisture content limits their range of usefulness.

In some parts of the country considerable quantities of lime are produced as by-products in certain industries, e.g., from paper-works and sugar beet factories. This lime is usually in the form of carbonate and its value depends largely on its degree of dryness. When dried it corresponds to very finely ground chalk or limestone and two firms have installed drying plants and provide an excellent product for which there is a keen demand. In the wet state, it is expensive to transport and difficult to apply uniformly.

How much lime should be applied?—There is a constant drain on the lime in the soil through losses in drainage and through the amounts removed in crops, stock and other farm produce. These losses may be made up to some extent by the weathering of soil minerals, but, on most soils, it is necessary to apply lime periodically if fertility is to be maintained.

The greatest loss is through drainage and this may amount to as much as several cwt. (expressed as oxide of lime) per acre per annum. It varies greatly in different soils, being highest in well-drained soils well supplied with lime, and usually very low in extremely acid soils. The amount lost is also influenced by certain fertilisers. Some of these, especially ammonium salts, increase the loss of lime whilst others leave basic residues which help to reduce it.

As the losses of lime from the soil are so variable, it is difficult for the farmer to estimate how much he should put back. He may get some indication that his soils require lime from the failure of certain crops such as barley or sugar beet, from the absence of clover in his pasture, from the prevalence of such weeds as sorrel and spurrey and from the occurrence of "finger-and-toe" in turnips, but the most satisfactory plan is to have his soils tested. By applying to the local agricultural organiser he can have, free of charge, advice as to the amount of lime required. This will depend on the crops grown; barley, sugar beet and wheat, for instance, require more lime than oats and potatoes.

Over-liming is not common, but it should be borne in mind that an overdose may bring about such diseases as grey speck in oats, heart rot in sugar beet and raan in swedes.

The amount of lime which should be applied at one dressing varies with soil conditions and crop rotation. If a soil has been allowed to become very acid, it should be put right by applying the amount of lime shown, by a soil test, to be necessary. This condition should then be maintained by regular dressings, say, once in a rotation, but it should be remembered that in light, sandy soils, which tend to lose lime rapidly, frequent small dressings are most suitable. The soils should, however, be tested from time to time, and the farmer should follow the advice of the agricultural organiser.

Where is the lime to be obtained?—There are signs that a great revival in the practice of liming is imminent. The Government is encouraging this through the lime subsidy, by which the farmer obtains a refund of half the cost of lime delivered to his farm, but there are still two obstacles. The first is that the supplies of lime are quite inadequate and the second is that the cost, particularly in districts far removed from sources of supply, is still too great. The Department of Agriculture for Scotland, from data collected mainly by Mr R. G. Betterton of the Agricultural Lime Department, has reviewed the lime position in Scotland and the results obtained under the Lime Subsidy Scheme during the first four years of its operation. The following notes are based largely on this review :—

1. *Amount applied.*—The total amount of lime (of all types) applied annually (1937-41) in the whole of Scotland was about 200,000 tons. The average amount applied per acre varied, in the different counties, from just under ½ ton to about 1½ tons. The smallest amounts per acre were applied as a rule in areas far from sources of supply or where the local supplies are inadequate or prices high, e.g., counties in the north and north-east.

2. *Percentage of arable land covered.*—In the period of four years (1937-41) this varied from about 5 per cent. in Inverness and Caithness to 27-30 per cent. in Lanark, Dumbarton, West Lothian, Dumfries and Ayr. Even in the latter group, however, this amounts to only 7 per cent. per annum, and a dressing once in six years would mean that 16⅔ per cent. would require to be dressed every year.

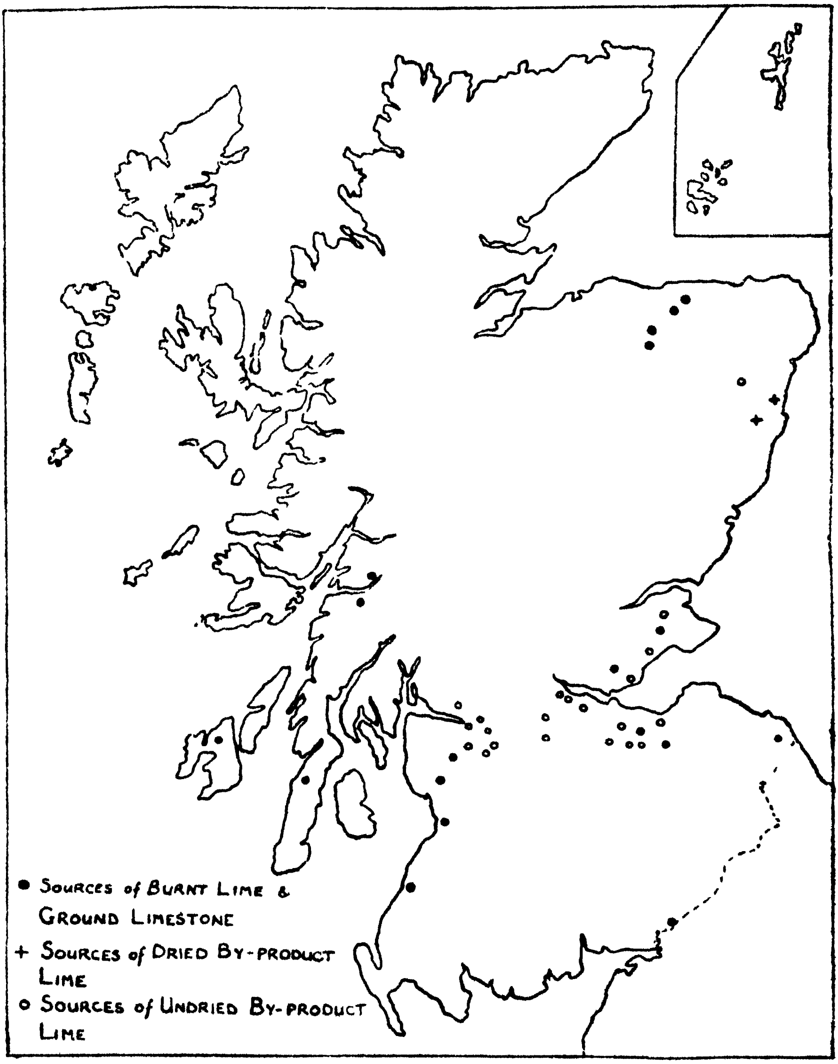
3. *Estimated minimum unsatisfied demand in 1940-41.*—In eight counties the estimated unsatisfied demand was over 50 per cent. of the normal demand, and it would appear that in the country as a whole many farmers have been unable to obtain supplies.

   The estimated unsatisfied demand in every county is only a small fraction of the need as indicated by soil tests. It must be difficult, however, to get a true estimate of unsatisfied demand as many farmers, having heard that there is a shortage, do not trouble to approach their merchants. Nevertheless, further intensive propaganda on liming will be needed as soon as supplies of lime are available.

4. *Prices per ton delivered on the farm (April, 1941).*—Lime containing 90 per cent. and over of calcium oxide (CaO) ranged from about £2 in Kirkcudbright and Lanark to £4 and over in several other counties; containing 70 per cent. CaO from £1 16/- to £4 2/6; containing 50 per cent. CaO

(presumably mainly carbonate) about £2 per ton. These differences in price probably mainly reflect differences in transport costs, but in some cases they must also reflect differences in production efficiency. If it were possible to have a flat rate for transport to any part of the country this would undoubtedly do much to encourage liming in districts where lime is badly needed, but where it is not being applied in sufficient amount because of high cost.

Farmers when purchasing lime should in every case



Present Sources of Lime (other than Shell Sand) in Scotland.

calculate the cost per unit delivered on their farms in order to ascertain if the prices charged are reasonable. This is done by dividing the cost per ton (including carriage) by the percentage of calcium oxide, e.g., if ground limestone contains 50 per cent. CaO and costs £2 5/- per ton delivered on the farm, the cost per unit is 540d. divided by 50 = $10\frac{4}{5}$d.

5. *Existing Scottish sources of supply*: (See accompanying map).—Lime in the form of burnt lime, ground limestone or dried carbonate of lime (from paperworks) is at present being produced at eighteen centres. Of these, two are in Midlothian, two in Fife, three in Ayr, one in Dumfries, four in Argyll, four in Banff and two in Aberdeen. The total production is about 83,000 tons of which 68,000 is burnt lime, 9,600 ground limestone and 5,300 dried paperworks lime. About 60 per cent. of the total tonnage and over 70 per cent. of the burnt lime is produced in Fife and Midlothian. During the past year, principally owing to A.R.P. (black-out) difficulties and labour shortage, a few works closed down and this has reduced output by 27,000 tons (all types), but there has been an increase of 6,000 tons at other works.

6. *Sources of undried by-product lime.*—As mentioned already, carbonate of lime is produced as a by-product in several industries such as papermaking. Two paperworks in Aberdeenshire, as already noted, dry this material and find a ready market for it, but the remainder is either sold in an undried condition or remains unused. It is estimated that a total of about 36,000 tons of this undried carbonate of lime is sold annually from 15 works and at other 8 works it is available for sale. The moisture content of this material varies, but much of it is wet which makes it costly to transport and difficult to apply.

7. *Proposals to increase production.*—The Secretary of State for Scotland is at present giving attention to the problem of increasing production in Scotland and has set up a Committee under the chairmanship of Sir John Milne Home to investigate the possibility of development of production from Scottish sources. Grants are at present available for the erection of new plant both for limestone grinding and waste lime drying. The following are the principal aims which, it is understood, the Government has in view:—

   (a) To expand production, especially of ground limestone, at existing works.

   (b) To install grinding plants at new limestone quarries or where limekilns have become derelict, particularly in areas

far from present sources of supply. Ground limestone is likely to be the most general liming material of the future.

(c) To dry by-product carbonate of lime. There are large supplies available at the sugar beet factory at Cupar and also at several other works.

(d) To encourage the use of shell sand and marl in certain districts. Shell sand is applied fairly extensively in Orkney, but there are many other places near the coast where it could be used. There is also a large marl deposit in Caithness which, if developed, would supply a wide district.

Particular attention is being given to the possibilities of developing new sources in regions far from existing supplies, for instance, in Caithness, Sutherland, Ross and Cromarty, Inverness, Argyll and Perth. The Geological Survey has re-examined the limestone resources of Scotland, and analyses of samples from all likely deposits have been made at the Macaulay Institute. This survey has shown that there are many untapped sources of excellent limestone throughout the country.

If the farmers in Scotland were to apply annually all the lime their soils require and if it were to be produced in Scotland, production would require to be about five times what it is at present. This ideal condition would entail the application of about 2 million tons of ground limestone a year for 4 or 5 years followed by a million tons annually. If the problem of liming the land is to be attacked seriously a bold policy of expansion must be adopted.

SUMMARY.

1. For a variety of reasons, liming has been neglected for many years, and three-quarters of the soils in Scotland are deficient in lime.

2. There is ample evidence to show that it pays the farmer to keep his soil well supplied with lime. Not only are yields increased, but there is an improvement in quality and palatability. Certain weeds are discouraged, and conditions are made less favourable for "finger-and-toe" in turnips, and better utilisation of artificial fertilisers is obtained.

3. Lime may be applied at any time except before deep ploughing or before a potato crop.

4. There is room for improvement in the methods of application, particularly with a view to saving labour, and an improved system has been described.

5. It is immaterial which form of lime is used provided equivalent quantities are applied. Ground limestone and other forms of carbonate have many advantages and are becoming increasingly popular. Less finely ground limestone would answer the purpose and would be cheaper.

6. The amount of lime required should be determined by means of soil tests which can be had free of charge through the County Organisers of the Colleges.

7. In many parts of the country lime has to be transported long distances. This adds greatly to the cost and is probably the major factor restricting the use of lime. Efforts are, therefore, being made to develop local sources and a survey of the country's lime resources has been made.

8. The demand at present exceeds the supply, and there are signs of a revival of the practice of liming. This is being encouraged by the Lime Subsidy Scheme, and to meet the increased demand production requires to be expanded. Probably no single measure would do more to increase agricultural production than adequate liming of the soil.

THE UTILISATION OF HILL LAND IN WAR TIME.

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IN considering how best to utilise hill land in war time there are a number of factors that one must take into account. In planning the maximum use that this kind of land can be put to one cannot treat it as isolated from other types of land: it must be so used as to be complementary, for that is the only way in which the maximum benefit can accrue to the community.

The system of cropping must, of necessity, be different from that of the lowland, and the use of the plough must be extended to a much higher elevation than formerly, and to more difficult land where ploughing has only become possible through the advent of the Caterpillar tractor and the very heavy digger ploughs. Further, on the hill land, as in the case of much third-rate land, increased ploughing does not necessarily mean increased production unless suitable crops are grown and the land manured and managed systematically. It should be laid down as a hard and fast rule that not more than one cereal crop should be taken from this type of land, even after pioneer crops have been grown to increase its fertility. The writer has very vivid memories of hill land that was ploughed up during the last war and cropped with two, and sometimes three, cereal crops, leaving the land in

such a state that no crop would grow on it even when heavily dressed with phosphate. It took years to form a sward, and a poor sward at that.

The real function of hill land during war time is to carry more stock, to fatten sheep on pioneer crops such as rape and turnips; if the land is bracken-infested then it can grow potatoes.

The question that now confronts us is how to treat this land so that it will pull its weight in the food-production compaign. That a vast increase in food production can be obtained from hill land has been amply proved by the results procured on the lands of the Cahn Hill Improvement Scheme at Aberystwyth. In pre-war days the scheme was criticised by some because the costs were high: in other words, because the improvements could not be produced at what the economists and financiers described as an economic return, although they could not dispute the tremendous increase in production and the transformation of poor, derelict, hill land at over 1000 ft. above sea-level into pastures the quality of which would put many a lowland field to shame. This statement means that the crops from these improved areas could not be sold at a price that would compare favourably with similar imported products. Now, however, that it is impossible to import these products our country is paying a heavy price for allowing financial interests to dominate policy to the ruin of agriculture and the countryside. The important thing is to produce food, and all the food that is possible, from our own soil.

The following description of some of the results of the work of the Cahn Hill Improvement Scheme may be of interest in this connection. Practically the whole of the work was carried out at an altitude varying from 1000 to 1300 ft. above sea-level: none of the land was flat, but with varying degrees of slopes; it was of low fertility, and in a district with an annual rainfall of over 70 inches.

The work can be classified into two main sections: I. Improvement of pastures by direct reseeding, and II. Growing of pioneer crops to increase the fertility, followed by reseeding.

Improvement of Pastures by Direct Reseeding.—Hill land must of necessity be looked upon as stock-producing land in contradistinction to arable land. Various methods have been experimented with to improve the pastures, and on dry land this means a combination of three things: (a) some system of cultivation to provide a suitable seed bed for the small seeds; (b) adequate manuring to give the young seedlings a good start and to maintain a good pasture afterwards; and (c) suitable seeds mixture.

Cultivations.—Before starting cultivations it is a very good thing to burn the roughage off the land. We have tested a great variety of implements with varying degrees of success. A good

deal of our first cultivation was done with an "Austral" rotary cultivator; another type of rotary cultivator, the "Fishleigh," was also used successfully on land that was free from stones. These machines pare off the mat and the top 2 inches of the soil, leaving a fairly clean surface with the soil in a consolidated condition, which is very important for clover establishment. Heavy discs and harrows have also been used, but all these cultivations have a serious drawback in times of emergency, in that the mat that is turned up is difficult and costly to deal with. We found that the most useful implement for collecting this debris was a road-sweeping brush. In normal times the best way would be to let the land lie fallow for a year after being cultivated with the rotary cultivator, giving it an occasional harrowing to help to disintegrate the clods.

The other method is ploughing, but it is very important to use a heavy type of digger plough similar to the Ransomes "Junotrac." This will turn over a completely flat furrow, and for this type of work a track-laying tractor is essential. The choice of method of cultivation depends largely on the type of soil, slope, and the use to which the land is going to be put. Much steeper slopes, and even wet, peaty land which would be impossible to plough, can be cultivated with the "Austral" rotary cultivator because of the way it is hitched on to the tractor. As a rule there is not much difficulty in getting a tilth on this type of land after ploughing. One of the best combinations for the work is a Cambridge roller, to which is hitched a steel flexible harrow. After harrowing down to a sufficiently fine tilth the land is rolled and the seeds and manures sown on the rolled surface. Covering is generally done with a moss harrow or a chain harrow with short tines, which can be hitched behind the manure distributor, so that the slagging and the covering can be done in one operation.

Manuring.—On the whole our results indicate that it is best to give a fairly liberal dressing of phosphate to start with. Basic slag of high solubility seems to give the best results: probably this is owing to its lime content. Ground limestone is also very valuable in this connection. On the other hand excellent results have been obtained with 6 cwt. of 30 per cent. slag and 1 cwt. nitro-chalk per acre at the time of sowing. This application would not keep the improved pastures in good condition for more than three or four years, and, therefore, it has been our custom to rephosphate every third or fourth year those areas that had light initial dressings.

Seeds Mixtures.—In the past on these poor lands it has been customary to use fairly cheap mixtures, comprising "seconds" of our Station-bred grasses with a fairly liberal addition of "seconds" of wild white clover, indigenous perennial ryegrass and

crested dogstail. If the proportion of crested dogstail was low in the ultimate mixture, then it was reinforced with commercial seeds. On the very poorest land, and for short-duration swards, Yorkshire fog was sometimes used, but this grass is difficult to control, because, unless it is grazed very hard, it tends to reseed, and it becomes badly burned during the winter months.

It is necessary to use a fairly heavy seed rate on poor lands, the mixture depending on the type of soil, duration of sward, etc. For the steeper and drier slopes Station-bred cocksfoot (Aberystwyth S. 26) is the basis of the mixture, with crested dogstail and wild white clover. On flatter land, and on loamy soils, Kentish indigenous perennial ryegrass, or Station-bred perennial ryegrass (Aberystwyth S. 23) are used. On wet, peaty land it has been found that Station-bred grazing timothy (Aberystwyth S. 48, or S. 50) is the best basis for a mixture. Generally speaking the ordinary commercial strains of perennial ryegrass, cocksfoot and timothy have only a short life under these conditions. The secret of success of a good hill sward, once it is established, depends on the maintenance of a high proportion of wild white clover.

There is often a tendency for most of the improved hill sward to revert gradually to an *Agrostis*-wild white pasture. From a hill farmer's point of view this sward, with a sprinkling of the better grasses, is in many ways one of the most useful for hill conditions. Some of the swards that we have established at Aberystwyth had a wild white clover content of approximately 20 per cent.

The question that now automatically arises is the use to which these improved swards can be put, and what has been the increase in stock-carrying capacity. These swards in their unimproved condition were in the main *Molinia* and *Nardus* swards, or, on the drier slopes, *Nardus*, bent-fescue swards. The average stock-carrying capacity of these would be about one store ewe and one store lamb per acre in summer, and about one ewe to two or three acres in winter. After improvement we have been able to maintain an average of two ewes per acre during the winter months, and four ewes and four lambs during the summer months. The majority of these lambs would be ready for the butcher by the end of July, or early August. During the three years for which records were kept, over 80 per cent. of the lambs were fat enough to be sold for slaughter under the Ministry's scheme: In this case it is not only an increase in stock-carrying capacity of from one to four lambs per acre, but at least three of these four lambs would be fit to kill for human consumption straight from the hill, whereas the one lamb that grazed there previously would only be in store condition and unfit to kill until it had been fed on lowland

pastures or on fattening crops. Previously this land would only keep mature cattle in more or less store condition: young cattle would not thrive, but, after improving, we have been able to graze young cattle very successfully on these swards during the summer months. Furthermore, we have been able to fatten three-year-old Welsh cattle on improved pastures ranging from 1000 to 1300 ft. above sea-level without any hand feeding whatsoever, and grade them in the autumn under the Ministry's scheme.

Numerous experiments have been laid down to test the value of heavy manuring of hill land not previously cultivated, and there has been a very pronounced difference in the way certain lands respond to manuring and reseeding without previous cultivations. On dry land the response has been extremely slow, and it takes some years to see any marked difference in the herbage. As a war measure, therefore, and for immediate results, this method is not very promising, but, as a pre-treatment, there is a lot to be said for giving heavy dressings of ground limestone to land that will later on be cultivated.

We have some very interesting experiments at Aberystwyth which we put down in 1930, and there is one plot where ground limestone was used at the rate of 4 tons per acre which has resulted in a very marked improvement in the sward, though it took some years to do it. On wet land, however, there is an immediate response to heavy dressings of phosphate and ground limestone, and these can be achieved without cultivation, except for opening up a few ditches to take the surface water away; this work can be done with a big plough like the "Junotrac" by taking off one of the bodies. The herbage one generally gets on this type of land in hill country is rushes, *Molinia, Nardus* and bent, and the first operation is the burning off of all rank growth: very often it is possible to get a good burn twice over. Phosphatic manures must be heavily applied to get an immediate response. Our best results have been obtained with one ton per acre of slag applied in spring with a light seeding of wild white clover and Station-bred perennial ryegrass sown in May. It is essential that this land should be heavily grazed with cattle, and horses if possible, throughout the summer to give the clover and the seedlings a chance to establish. After burning there is generally no difficulty in getting cattle stock to graze the land bare; horses are also very useful in this connection. It is also important to cut the rushes at least once during the summer months; all the better if this can be done two or three times. By the second year there is usually a tremendous improvement, and the land becomes one mass of wild white clover and good enough to graze young cattle and young horses.

With all these methods it is better to fence in the land so as

to protect the young seedlings, but we have been able to establish good swards, although the sheep were never off the ground.

The Growing of Pioneer Crops.—Another method of improvement is by growing pioneer crops for sheep fattening. This can best be done on areas which can be fairly easily ploughed and fenced in without too much expense. On areas that are fairly near the homestead and that can be brought into the ordinary farm rotation there is no doubt that this is the best method. We have been able to convert very poor hill pasture, comprising mainly *Molinia* and *Nardus,* with two or three crops of hardy green turnips and rape, into pastures composed mainly of the better grasses and a high proportion of wild white clover. The ploughing should be done with a heavy digger plough: plough a wide, flat furrow. Depth of ploughing is also important: as a rule it is not advisable to plough deeply the first time or too much sterile subsoil will be thrown on the surface, and difficulty will be experienced in getting a "take" (see section on cultivations above). The general seeding that we have used is 3 lb. of rape and 2 lb. of hardy green turnips. If the land is not to be seeded down to pasture then it is advisable to add about 16 lb. of Italian ryegrass and 5 or 6 lb. of ribgrass to provide autumn and spring keep for the sheep, and as much phosphate as can be spared, up to 6 cwt. per acre, plus 1 cwt. nitro-chalk, should be used at the time of sowing in order to give the crucifers a good start.

Last year (1940) store lambs from the mountains were a drag on the market, and many hill farmers failed to dispose of them because the lowland farmer, owing to the extra ploughing, had no aftermath or rape crops to spare. By utilising hill land to fatten these lambs one is doing two things, namely, providing additional meat supply for the nation, and increasing the fertility of the land itself.

Live-weight increases ranging from 80 to 125 lb. per acre have been obtained with pioneer crops at altitudes of over 1200 ft. After growing pioneer crops the land is generally in a good enough condition to grow a cereal crop, if that is necessary from the national point of view, but it is a mistake to take too many cereal crops from hill land.

Our land is limited, and it is necessary again to emphasise that it is essential, if we are to get the maximum food from the hill land, not to overcrop it with cereals.

Bracken land.—The writer during the last few years has carried out a number of experiments on the eradication of bracken, and an article giving these results has been published in the current issue of the *Welsh Journal of Agriculture,* Volume 16, p. 227. It was found that the bracken on land heavily infested will

be eradicated in one operation if ploughed during July and August. It has also been found that the soil of bracken-infested land usually has a high potash content, and generally a high phosphate content as well. In order to get the best out of this type of land, and to utilise our tractors and machinery during the slack period, bracken-infested land should be ploughed during June and July, and cropped the first year with hardy green turnips for lamb fattening. It would then be in an ideal state for growing potatoes in 1942. As a matter of fact yields of potatoes ranging from 8 to 10 tons per acre, with artificial manures only, have been obtained in 1940 from this type of land that was ploughed in August, 1939. There are also large areas of bracken and gorse and scrub land in this country, at lower elevations, that would yield good arable crops if cleared and cultivated, and would give better and quicker returns than the wet lands that are now being drained, and a similar grant should be made for clearing these lands as is now available for draining wet land.

Livestock.—Reference has already been made to the increased stock-carrying capacity of these improved pastures under their respective headings.

In addition we have carried out some experiments on the grazing of cattle and horses on unimproved mountain land; most of the work that we have done has been with Welsh Black cattle, and we have successfully grazed two or three-year-old heifers and dry cows on *Molinia* pastures at altitudes ranging from 1500 to 1700 ft. above sea-level. There is no doubt that there are huge areas of unimproved hill pastures in Wales, and more in England and Scotland, which could, if a proper scheme was organised, carry a large number of cattle during the summer, but this would only apply to the hardy dual-purpose or beef breeds. We have been pampering our dairy cattle during the last twenty years with imported feeding-stuffs and have been breeding for excessive milk yields, so that it is possible the superior dairy breeds may not be suitable to graze at these altitudes. Experiments carried out in Italy and Switzerland seem to indicate that a period of summer pasturage at high elevations tends to improve the stamina and health of cattle. There is tremendous scope for further investigation along these lines, but precautions would have to be taken to safeguard against the introduction of diseases such as contagious abortion and mastitis. If such a system could be universally adopted over a number of years it would mean the reorientation of all our breeding ideas, because then the breeds of cattle that can deal most effectively with rough pasture and rough fodder would be the ones to utilise. If the whole economy of agriculture was planned for maximum production then the lowlands would be used to an increasing extent for cereals and for

producing high-protein foods, such as kale and silage to be used with the straw, and what little hay was made to feed the cattle during the winter months, and then towards the end of May a large cattle population would be transferred from the lowlands to the hills. It might also be possible to produce a good deal of cheese and butter from hill pastures during the flush period of June and July. As a matter of fact it is possible with a hardy type of cow to get yields of milk up to two gallons per day from young *Molinia* pastures. Young horses will also do quite well over a period on these hill swards. What about Hosier bails on the hills, and the adoption of Welsh Hafod and Scotch sheiling again in this country, as was the custom centuries ago?

PREDIGESTION OF STRAW.

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During war time, owing to the reduction in imports, it is essential that the greatest use should be made of all home-grown foodstuffs. There has been a very large increase in the acreage under cereals, and attention has been given to the best use to be made of the straw portion of the crop. Although straw contains reasonably large quantities of carbohydrates, its use as a fodder is beset by the double difficulty that, on the one hand, its bulky character limits the extent to which it can be consumed by the animal, while, on the other hand, its tough and fibrous nature reduces its digestibility, and hence there is only a comparatively small surplus of energy left after the work of digestion to serve productive nutritional purposes.

The object of the process of predigestion of straw is to enhance the nutritive value of the straw by increasing its digestibility. The process is by no means new. It was carried on in Germany during the last war on a fairly extensive scale both on farms and as a manufacturing process. A certain amount of investigation of the process was also conducted during that period in this country. During the last two years the theoretical basis of the process and its practical application in farming have been examined, and a simple form of equipment capable of use on the farm by semi-skilled labour has been designed by Imperial Chemical Industries, Ltd.

Method of Treatment.—The process is a comparatively simple one and consists essentially in soaking the straw, after chopping into lengths of 2-3 inches, in ten times its weight of cold 1·5 per cent. caustic soda solution for a period of 20 hours, although

this time may be considerably shortened. The soaked straw is then taken from the steeping tank and thrown on the ramp to drain, and finally transferred to another tank and washed free from soda by running water. It is estimated that 4000-6000 gallons of water are required for the treatment of one ton of straw. The pulp may be fed in the wet state at any time up to one week after making. It is not advisable to feed pulp over a week old. The process can be applied to wheat, barley or oat straw or to wheat or barley cavings.

The main essentials are :—

1. A chaffing machine for cutting the straw into 2-3 inch lengths. The straw cannot be used in the long condition because, after treatment, it is almost impossible to wash such material free from soda.
2. A suitable plant consisting essentially of two long narrow concrete tanks separated by a ramp on to which the straw is thrown to allow the soda to drain away.
3. An ample supply of running water for washing the straw.

Experimental Investigations.—Work which has been in progress at a number of centres in England and Scotland to determine the effect of the process on the nutritive value of the straw has proceeded along two main lines :—

1. Trials with sheep designed to determine the change in digestibility of the constituents of the straw and hence the increase in its starch value, after making allowance for soluble materials lost in the process.
2. Feeding trials, mainly carried out with bullocks or growing heifers, in which the relative nutritive value of the straw, before and after treatment, was examined.

In addition, plants have been set up on a considerable number of farms and worked under ordinary conditions by the usual farm staff. The product was fed to stock, not under experimental conditions, but with the effects simply recorded from the observations of the farmer himself.

Results—1. *Digestibility Trials.*—Experiments with either oat, wheat or barley straw grown in England have shown that the digestibility of the dry matter of these straws was increased by 30-40 per cent.; that of the N-free extractives by 25-30 per cent., and that of the fibre by 40 per cent. or more. Similar results have been obtained with oat straw grown in Scotland and not so fully ripened. The values for the digestibility coefficients gave a figure for the starch equivalent, on a dry matter basis, of the order of 45 for all three types of straw as compared with 20-25 for the untreated straws. As, however, the wet pulp contains, as a rule,

only about 20 per cent. of dry matter, this would give a starch equivalent value of 9 for the pulp as prepared and fed. In assessing the value of this process on the basis of these figures, the loss of soluble constituents during the treatment must be taken into account. The values obtained in the English experiments showed an average loss of dry matter of the order of 19 per cent., whereas in Scotland the value obtained for oat straw was 30 per cent. These facts need to be remembered, as will be seen later, when consideration is given to the general application of the process.

2. *Feeding Trials.*—In planning such trials and in the use of the straw pulp in general practice it must be remembered that the material is a carbohydrate-rich substance, containing little or no digestible protein, and that its inclusion in a ration, like that of straw itself, may reduce to some slight extent the utilisation of the protein in the concentrates of the ration.

A considerable number of trials have been carried out on experimental farms in various parts of England and Scotland. With one or two exceptions no difficulty has been experienced in getting cattle to eat the wet pulp, the general consensus of opinion being that the material is quite palatable and readily eaten by cattle in quantities up to 70-80 lb. of pulp daily. The results obtained at the various centres do not, however, show such general agreement.

In England, with two exceptions, the increase in nutritive value of the straw as the result of predigestion, as measured by the extra live-weight increase of the cattle, was of an order to be expected on the basis of the results from the digestibility trials referred to above. Although the pulp from wheat straw was less readily eaten than that from barley or oat straw, nevertheless it was consumed in reasonable amounts; when it is remembered that untreated wheat straw is hardly ever fed the results with this material must be considered satisfactory.

In Scotland the results obtained were not generally so satisfactory or in such consistent agreement. At one centre a positive result was obtained in one experiment, but in two other experiments no increased live-weight gain was obtained as a result of the treatment. At two other centres the results would appear to indicate that, as far as oat straw is concerned, not very much improvement can be expected in its nutritive value from treatment with caustic soda. At the fourth centre the result was definitely in favour of the predigested straw, particularly during the winter feeding period, although the difference between the two groups on the untreated and predigested straw respectively was not anything like the magnitude of the results obtained in the

English experiments, but it must be noted that the amount of straw used in these rations was lower.

The general opinion of farmers, who have had plants erected on their farms where the predigestion of the straw and feeding of the pulp is carried on as part of the general practice, is that the process is simple and easy to work. It is not foolproof, but, with reasonable care, no harm need result to the farm hands or to the stock. The cattle soon become accustomed to the straw pulp and consume it readily, if due attention has been paid to adequate washing to remove all the excess soda from the straw.

Before discussing the general application of the process brief reference may be made to one other point. The above experiments were all carried out with ruminants. It may be stated here that, although pigs will eat the straw pulp quite readily, it does not appear that the material can contribute anything to the nutrition of the growing pig; however, in times of acute food shortage straw pulp might be included in the ration of breeding stock. Actual digestibility trials with growing pigs of about 100 lb. live weight showed that the digestibility of oat straw by these animals was definitely increased as a result of the predigestion process, but even so the value for starch equivalent of the straw was negative.

General results and application of the process.—The experimental results, as a whole, indicate quite clearly that the predigestion of straw, whether oat, barley or wheat, with cold caustic soda does increase the digestibility of the straw and hence its starch value. At the same time it would appear that the enhancement in nutritive value of the straw by the treatment in Scotland is not likely to be as great as in England. This is almost undoubtedly owing to the fact that in Scotland, where good quality oat straw is produced and normally fed to cattle, this straw is cut at a stage where it is much less ripe than straw harvested in the south of England. It contains, in consequence, a greater proportion of soluble ingredients, which will be dissolved out and lost in the treatment. Such losses must be first made good by the predigestion process increasing the digestibility before any net gain can be expected from the process. Thus from analyses of samples of Sandy oat straw grown in the north of Scotland and in England respectively, made some years ago, it was found that the Scottish straw had 51·3 per cent. of N-free extractives of which 13·2 per cent. were actual sugars, whilst the English straw had 47·3 per cent. of N-free extractives, of which only 2·4 per cent. were actual sugars. It is obvious that the Scottish straw would lose more soluble N-free extractives during predigestion in soda than would the English straw. These remarks apply equally to barley straw containing clover and grasses, as it very frequently does, since there would be a large loss of nutrients from the

"seeds." It should be stated here that in the case of straw which has become at all musty as a result of wet and difficult harvesting conditions, it was observed at one centre that the predigestion treatment effected a definite increase in the palatability of the straw and thus had a markedly beneficial effect.

In conclusion, in arriving at any decision as to whether the process is applicable or worth while on any given farm or on any given area, there are certain points other than the enhancement of nutritive value which must be given consideration, viz. :—

a. It is absolutely essential that the straw be chopped into short lengths before predigestion. If a cutter is not available it is useless to consider embarking on the process.

b. A suitable plant costing something of the order of £30 must be erected and the cost of soda (about £1 4/-) and of labour (about 16/-) per ton of straw borne in mind. It may be noted that at the one Scottish centre, where a definitely positive result was obtained, the cost of soda alone for each pound of live-weight increase was 4d.

c. Consideration must be given to climatic conditions, particularly if the plant is erected out of doors under a lean-to roof. Whilst experimental data indicate that low temperatures down to just short of freezing point have little, if any, influence on the results if the steeping proceeds for 20-22 hours, it is doubtful whether the plant could be worked out of doors in those areas where heavy and continuous frosts occur.

SCOTTISH AGRICULTURE IN WAR TIME.[1]

As in the previous year the weather of the opening months of 1941 proved to be a great disappointment to farmers. Faced with an increased tillage programme, they had hoped to get the greater part of their lea and stubble ploughing completed by the end of February. This would have enabled them not only to take advantage of the earliest sowing weather, but also, provided the season were suitable, to complete the sowing of their grain crop early in April.

But their plans went sadly agley: the snowstorm, which ushered in the New Year, held the land in almost constant grip for about nine weeks. This snowstorm was succeeded by a bitter frost, and the thaw, when it came, was slow and unsatisfactory. The story of the first two months of the year was of one blizzard succeeding another at short intervals. Never within living memory

[1] This article is in continuation of articles which appeared under the same title in the January, 1941, and July, 1941, issues of the Journal (Vol. XXIII., Nos. 2 and 3) covering the period September, 1939-December, 1940.

had there been such a time of blocked railways and roads, of passengers being marooned in the wilds, of towns, villages and farmhouses being isolated for long periods, of hill sheep suffering the greatest hardships. In many parts sheep could neither be brought to the hay, nor the hay to the sheep. The only saving grace about those recurring storms was that the snow saved the unpulled turnips from being destroyed, as so many were a year previously. During the first two months of the year, when the ploughs were rusting in the furrows, many of the hill sheep were gradually reaching the "saucy" stage—a stage when they appear to lose the very will to live. Consequently, when a blizzard of great severity swept the north of Scotland on the 27th of March, quite a third of the flock on some of the grazings perished, while many of those that survived were deemed to be as good as dead. And in other districts the cumulative results of the various snow-storms were most disastrous. Never had such a high death-rate amongst hill sheep been experienced; never had the lambing rate been so low.

Spring, 1941.—As soon as ploughing became possible, as it did in the low ground areas late in February or early in March, it was pushed forward with all speed. Every tractor that could be bought, hired or borrowed was worked to its fullest capacity. So quickly was the land turned over that many farmers in certain areas were able to take considerable advantage of a sowing spell which set in soon after the middle of the month. Unfortunately, this spell came to an untimely end on the 26th of March when it was succeeded by snow and wet weather. When the snow had cleared away, the lea ploughing was resumed, but the ploughing of the red or clean land was quite out of the question because of its wet condition. But even this latter hold-up was utilised in the interests of food production. A number of farmers who had finished their programme of lea ploughing, ploughed more than they had originally intended to do rather than see the ploughs remain idle. Eventually the weather cleared up; sowing again became possible, and by about the beginning of May most of the grain crop had been laid down under fair conditions. This belated sowing, as it turned out, was not so harmful to oat yields as might have been expected, probably because the whole procession of the spring months seemed to march three weeks behind the customary time-table. April resembled an ordinary March, May an ordinary April. Gradually, as time went on, arrears of work were overtaken. In the eastern arable districts most of the turnip crop was laid down by the end of the first week of June. Farther north and on isolated farms everywhere, particularly on those without a tractor, the laying down of this crop dragged on until the beginning of July.

Summer, 1941.—Soon after the middle of June a welcome change took place in the weather. For months on end the winds had remained quartered in the north or north-east. They now veered round to the south-west; a heat wave set in and, thanks to the abundance of moisture in the soil, crops of all kinds made rapid and satisfactory progress. Hay cut and coled during this spell was secured in excellent condition. Unfortunately, the weather broke down in the second week of July and continued rainy and unsettled until the end of August. Yet the summer was by no means cold, and grain crops in inland districts were only a day or two later in ripening than they were in 1940. All along the eastern seaboard, however, mists and fogs retarded ripening, and in these districts harvest was commenced a fortnight to three weeks later than in some of the adjoining inland areas.

On the whole, the summer favoured the growth of all crops. Wheat in most districts was a good crop; in some, however, the effects of the hard winter and cold spring had thinned out the plants badly, and a certain acreage had to be ploughed up and resown to other crops. Barley and oats, except where they had been sown too late, promised well. The potato crop, despite late planting, had seldom presented so luxuriant a foliage, but, unfortunately, root development was slow and an attack of blight, which started in the south-west about the last week of August and swept across the centre and parts of the north of Scotland, prevented the full development of the tubers. Elsewhere blight checked the growth of the haulms very little, while few of the tubers were affected. The weather during July, August and September favoured the growth of grass and roots.

Harvest of 1941.—The various steps taken to deal with the labour difficulties are mentioned elsewhere in this article but, meantime, it may be said that, after an unsatisfactory start with the grain harvest in August, farmers were favoured during most of September with a fine spell of warm, sunny, but distinctly slow, windless weather. The grain crops, though heavy, were not nearly so broken as they were the previous year; little grain was shed either before or during the cutting process and rapid progress was made. Indeed, towards the end of September, too rapid progress was made, with the result that considerable heating in the stacks took place. By this time the greater part of the grain crop had been secured, but in the later districts of most counties considerable acreages of crop were still outstanding at the beginning of October. From that time onwards the grain harvest was most unsatisfactory. The weather became broken; there were no drying winds until about the end of the month and farmers had to undergo the tantalising experience of seeing one day succeed

another without being able to do anything to save their grain crop. Towards the end of October a dry spell enabled a considerable part of the outstanding crop to be stacked, but even then, in quite a number of districts, some of the grain crops remained unsecured until well on in November. The lifting of the potato crop was also greatly protracted, not quite so much on account of the weather difficulties as of difficulties experienced in getting sufficient pickers to lift the greatly increased acreage of this crop. Fortunately, most of the crop was pitted by mid-November before frost had caused appreciable damage.

Crop Results, 1941.—Taken all over, the results of the 1941 food-production campaign were highly satisfactory. The preliminary figures of agricultural returns for the year showed that there had been some 271,000 extra acres brought under tillage. Not only so, but the greater part of the heavy grain crops was secured under fairly good conditions. The results of the earlier threshings indicated that the grain crop was likely to thresh well. Crops yielding nine to ten quarters of oats per acre seemed to be common, while such high yields as fourteen quarters of oats and nine of both barley and wheat were reported. Potato yields, though below those of last year, were, on the whole, good, while turnips and sugar beet bulked well. In the aggregate the object aimed at was not merely achieved; it was surpassed.

Improving Cultivation Standards.—A slogan misapplied may become a dangerous weapon: it may be used to misinterpret facts, to pervert truth. The slogan "bushels not acres" is a healthy reminder to all engaged in food production that time, energy and expense can yield the best results when concentrated on the most fertile land. Repeated parrot-like by persons insufficiently acquainted with facts, such a slogan may suggest, and indeed was used to suggest, that committees in their zeal to obtain their cultivation quotas were not merely responsible for breaking up much second and third-rate land, but neglected the cropping of the more fertile land. Far from this being the case, committees not only encouraged the most efficient productive management of fertile land, but did their best, in the absence of overriding reasons, to dissuade farmers from cropping unsuitable land. Moreover, where, in the opinion of the committee, land was not yielding to its fullest capacity, steps were taken to ascertain the cause and provide a remedy. Where voluntary methods were ineffective, or seemed likely to be so, use was made of the power delegated to committees to issue directions in regard to drainage, manuring, etc., to terminate tenancies and to take possession of land. In default of directions being carried out the committee could step in and carry out the work.

Gratifying results were obtained on farms taken over and worked by committees. In one instance land considered to be too poor to bear profitable crops yielded, after being suitably cultivated and fertilised, over 7 quarters of oats per acre; in another case, that of a high-lying arable holding, yields of over 6 quarters of oats and of 10 tons of potatoes per acre were obtained on land which previously had barely returned the seed sown or planted. These good results were due to a combination of causes, viz., efficient and timeous cultivation by means of tractor-drawn ploughs and disc harrows, effective manuring, use of suitable varieties and a favourable season. As against this, where poor crops were to be seen on privately occupied farms the bad results could generally be attributed to some of the following causes:—late and bad ploughing, late sowing, unsuitable varieties of grain, etc., and insufficient manuring. Some farmers also, who wished to benefit from the £2 per acre subsidy for the ploughing up of grassland, were prepared, in the interests of laying their poor grassland to better pasture, to break it up, although it might fail to produce a profitable crop the first year.

Special Crops: Potatoes, Sugar Beet and Flax.—To meet the expressed wishes of the Government for an increased production of potatoes and sugar beet, many committees arranged that directions were issued to individual farmers requiring that a minimum area of potatoes should be grown. Only by two committees were similar steps taken in respect of sugar beet, and here directions were confined to farmers who possessed suitable soil for the growth of this crop. In most instances committees relied on the voluntary efforts of farmers to produce the desired acreage, but the results so obtained were somewhat disappointing. So far as flax was concerned, the good results obtained in 1940 led to a further large increase in the acreage grown in 1941. To deal with this increased acreage two new factories were set up in Aberdeenshire and Fife. Despite late sowings the crop was good, but some difficulty arose at harvest time. The pulling machines supplied were not always effective, while the delays occasioned by late sowing, etc., had the unfortunate effect of bringing this harvest into some degree of competition with the grain harvest.

Stock Adjustments, 1941.—In the previous year the stock adjustments consequential on the food-production campaign had been slight. In 1941, however, owing to the very large decrease in the acreage of grass, considerable adjustments in the numbers of stock were inevitable. To a large extent these had been met by the disposal of many of the low-ground sheep in the fall of 1940. Further reductions in numbers of cattle were still necessary, particularly on those farms in the more fertile arable districts

where farmers had been in the habit of using their available grass for pasturing older cattle intended to be fattened. Such pastures had largely ceased to exist. On dairy farms, and on farms where cattle breeding was carried on, a considerable proportion of the farm is usually in grass, and there the effects of the ploughing-up campaign were less seriously felt. On these farms, by means of manuring, grazing the younger cattle on the rough grazings and taking up the previous "slack" it was found possible to carry much the same numbers as in the previous year. Fears were not realised that the prices of store cattle would slump in the spring and early summer owing to the scarcity of grass in relation to the numbers of available animals. Indeed, it was the other way about. There was a serious shortage of grazing animals owing to (1) the stoppage of the importation of Irish cattle due to an outbreak of foot-and-mouth disease and (2) the poor lambing season on hill farms. The season, moreover, was eminently suitable for grazing. On certain individual farms the numbers of stock pastured were actually the same as before the war. Yet those farms had added largely to their tillage areas.

Maintenance of Fertility.—In 1941 there was little evidence that the fertility of the land was being impaired. The stored-up fertility of the ploughed-up pastures, particularly the wild white clover pastures, was still only in the process of being utilised; a higher general level of manuring had made good the losses of plant nutrients due to cross cropping; the use of the modern tractor plough for effectively ploughing old turf and the tractor-drawn cultivators for stubble cleaning helped to keep the land clean, and the urge given to land drainage by drainage grants on the one hand and directions on the other brought wet land into full yielding capacity. Indeed, far from there being any indication that the land was being impoverished, there was every appearance of its being improved. The acreage of worthless pasture was visibly shrinking; land which had been bog for many years was now being dried; the poorly managed farm was yielding better crops, while the previously well-managed farm looked as well as ever it had looked. More and more the intelligent farmers came to regard the ploughing-up campaign as their great opportunity for bringing the poor grassland of the farm into profitable production. The grassland subsidy of £2 per acre was a great incentive to the destruction of worthless sward and re-establishment of a good one. Other means towards that end were the modern tractor-drawn implements, the assistance given towards the purchase of lime, and the satisfactory prices for grain and potatoes. The plough in such cases, far from destroying fertility, became the means of enhancing it. The plough was not merely the means of increasing total production of crop; properly applied it became the instrument for

the maintenance, if not the increase, of the numbers of our larger livestock.

The Grassland Subsidy Scheme.—The scheme under which a subsidy of £2 per acre is paid in respect of land which has been under grass for at least seven years and which is ploughed up and brought into a state of cleanliness and fertility was extended during the year to apply to all such grassland ploughed up before 31st March, 1942. The area of land broken up under this scheme for crop production for the 1941 harvest amounted to some 248,000 acres. In addition to this, notifications of intention to plough under the scheme in time for the 1942 harvest had been received by the middle of November. These latter notices covered some 17,500 acres.

Utilisation of Deer Forests for Grazing.—During the year the Agricultural Executive Committees in the Highland area continued their efforts to ensure that deer forest grazings were used to the fullest extent practicable for sheep and cattle. Steps were taken to induce forest owners to make the grazings available, and to make the necessary particulars known to farmers. The resultant demand for the use of such grazings was, however, not extensive. There were two main reasons for this. Despite the increased area put under the plough, grazing facilities on most farms had not been so seriously restricted that the occupiers were forced to face the expense and risks associated with the despatch of their stock to deer forests for summer grazing. The severity of the preceding winter had, moreover, reduced the numbers of the suitable stocks for putting on the forests. Supply of stock was in fact the limiting factor in the development of deer forest grazings during the year. Nevertheless, some further progress was made, and the numbers of sheep and cattle on deer forests at 4th June, 1941, were almost double the numbers on the forests at 4th June, 1939.

In addition to the two deer forests already in his possession the Secretary of State took possession in June, 1941, of a deer forest covering an area of some 12,000 acres. 1,720 sheep were put on this forest during the autumn. Some 5,000 acres, on another deer forest were taken over in May, 1941, for summer grazing of sheep.

Termination of Tenancies.—The powers to terminate tenancies in cases where tenants are not cultivating their holdings according to the rules of good husbandry, or where they have failed to comply with directions issued by committees, have not had to be exercised extensively in Scotland. Up to the end of 1940, 21 tenancies had been terminated. By November, 1941, this number had risen to 43.

Taking Possession of Land.—The Secretary of State's power to take possession of land in order to ensure its proper utilisation for food production was exercised in a number of cases during the year. The following statement shows the number, character, and acreage (a) of the subjects which had been taken over up to the end of 1940 and (b) of the subjects taken over during the period January to November, 1941.

	Taken over before 1st January, 1941.		*Taken over since 1st January, 1941.*	
	No.	*Acreage.*	*No.*	*Acreage.*
Arable and Mixed Holdings	17	4,868	29	2,824
Sheep Farms	3	43,360	1	2,015
Deer Forests	2	55,318	2	17,000
	22	103,546	32	21,839

Plans for 1942.—In the early summer of 1941 plans were being formulated for the 1942 season, and in the middle of July instructions were issued to Agricultural Executive Committees as to the lines on which they should proceed. Great as had been the progress already made in increasing the acreage under the plough, it was felt that it was possible to secure a still further increase. The general aim of the 1942 programme was to bring the area of tillage in Scotland up to its maximum level. To each committee was allocated an objective and detailed instructions were issued as to the basis on which different types of farms should be treated. Committees were also asked to make every effort to see that the potential agricultural resources of such land as policy parks, golf courses, sports fields, vacant plots of land in and around towns and all under-farmed grasslands were utilised to the fullest extent possible. It was pointed out, too, that the stage had now been reached at which it would be necessary to exercise a greater measure of control over the crops to be grown on individual farms. Cropping policy had to be related to the nation's need for certain crops for human food and to the requirements of the livestock population. Special instructions were issued as regards the acreage of wheat, potatoes, barley and sugar beet to be grown. Emphasis was also placed on the importance of securing increased production by stimulating improvements in the general standard of cultivation.

Grass Silage.—The imperative need for being as self-sufficient as possible in the matter of feeding-stuffs led to the launching of a silage campaign in the spring of 1941. By that time shipping difficulties had increased and a rationing scheme for farm animals

was introduced. To make up for the shortages, farmers were urged to grow as much of their feeding-stuffs as they possibly could at home. Young leafy grass is in itself a balanced, if a somewhat watery, food; successfully preserved in the form of silage it incurs little loss, either in the amount of feeding material or in the degree of digestibility. Meetings and demonstrations were held at suitable centres and arrangements were made for giving expert advice on the making of grass silage where and when required. The results of the campaign were apparent chiefly in the dairying districts and were on the whole gratifying. Shortage of grass in the early summer prevented farmers setting aside as much of their grassland for silage as they would have liked, while towards the end of the season, when grass was plentiful, pressure of other work interfered with the making of silage. Nevertheless considerable quantities of such silage were successfully made, and a noticeable improvement in methods of making was observed.

Government's Tractor Reserve.—Increasing demands were made on the services of the Department's motor tractor outfits, which are made available through the medium of Agricultural Executive Committees to undertake work which farmers are unable to carry out with their own machinery or the aid of local contractors. In the spring of 1941 some 50,000 acres were ploughed by the Department's outfits, and other cultivations were carried out on 75,000 acres, as compared with 12,000 acres ploughed and 22,000 acres cultivated in 1940. During the harvest the Department's binder outfits cut some 60,000 acres. Outfits were also made available for the lifting of the potato crop.

Owing to production difficulties there was some delay in the delivery of the additional threshing mills which had been ordered for the season. In the interval the twenty-five machines acquired last year were used fully, and the new mills were put into commission as quickly as they became available.

During the past two years extremely heavy demands have been made on the Department's outfits in the late spring, while in the autumn months, when conditions for ploughing are often ideal, there has been little call on the service. To induce farmers to put their work in hand early and thus avoid the difficulties of a late spring rush, the Department decided to grant a rebate of 10 per cent. on accounts rendered in respect of ploughing orders booked before 1st December, 1941, for immediate execution. There has been a satisfactory response to this concession.

Registration of Agricultural Contractors.—With a view to enabling Agricultural Executive Committees to organise to the fullest possible extent all the resources of agricultural machinery in their area, an Order was made requiring agricultural contractors

to register by 1st November, 1941, with the Committee in whose area they operated; to furnish particulars of their plant; and to comply with any directions given by the Committee as to the operation of their plant. The indications are that, as was desired, the necessary organisation is being effected on a voluntary basis.

Importation of Agricultural Machinery.—The Minister of Agriculture and Fisheries has become the sole importer of all agricultural machinery from the U.S.A. under Lease-Lend arrangements and from Canada. The distribution of the machinery on arrival in this country continues to be made through the normal trade channels, but before a farmer may place an order for an imported tractor or implement he must obtain a certificate of need, which, in Scotland, is granted by the Department on the recommendation of the Agricultural Executive Committee for the district.

Seeds.—On account of the greatly increased demand for agricultural and vegetable seeds, a close watch requires to be kept on the supply position and on prices; these matters are the subject of frequent consultations between the Agricultural Departments and the various bodies representing growers and seedsmen.

Having been deprived of certain important continental sources of supply, this country now depends to a much greater extent than formerly on home-produced seeds and on imports from U.S.A. and New Zealand. Steps have been taken to stimulate home production of seeds, notably grasses, clovers, and roots, and large supplies have been reaching this country from New Zealand and U.S.A. As regards imports from the latter country, these are now made under Lease-Lend arrangements which entails the cessation of private trading. The exportation of seeds is practically prohibited.

Until October 1st, 1941, when the Agricultural and Vegetable Seeds Order came into operation, seeds were free of control, although by voluntary arrangement a considerable measure of collaboration existed between the Agricultural Departments and the seed trade. This Order imposed a modified scheme of control on the trade in that growers were obliged to sell their seeds to licensed seedsmen comprising wholesale firms and retail firms in the habit of purchasing supplies on a substantial scale from growers. In certain cases firms were licensed to deal only in a few kinds of seed. In turn, licensed seedsmen were forbidden to dispose of seeds except to growers for sowing or to other persons for resale for sowing.

Fertilisers and Lime.— Spring deliveries of artificial fertilisers in 1941 proceeded in the main normally, quantities ordered by farmers being considerably in excess of those of pre-war years.

In 1940-41 the use of potash was restricted to selected crops and to inclusion in compounds. The supply position necessitated considerable further restriction for season 1941-42 and maximum allocations per acre were laid down for certain selected crops such as potatoes, onions, carrots, flax, sugar beet, tomatoes and root and vegetable crops grown for seed on contract.

The phosphate position remained, on the whole, satisfactory, and it was arranged that Scotland should obtain for 1941-42 season a quantity of basic slag approximately equal to that which had been received the previous year.

The question of lime supplies continued to occasion some anxiety, and the administrative responsibility for increase of production was taken over in July by the Agricultural Lime Department (U.K.). This body will also administer the subsidy on lime which has been extended until 31st July, 1944. In addition the Department have appointed a Technical Committee to advise them on questions relating to the development of new sources of supply in Scotland.

Feeding-stuffs.— During the winter period, October, 1941-April, 1942, no attempt is being made to ration all farm livestock as was done when the Rationing Scheme started in February, 1941. Instead it is assumed that all farmers have now carried out the Government's injunction to make their farms as self-supporting as possible. As a corollary farmers are allowed to use grain (excepting wheat) of their own growing for feeding to their livestock. The limited supplies of feeding-stuffs available for distribution as rations are devoted mainly to dairy cows, to essential working horses and, within limitations, to pigs and poultry. As regards dairy cattle there is the paramount need of maintaining the milk supply, while in the case of pigs and poultry a very large proportion were in peace time entirely dependent on purchased imported feeding-stuffs. Rations for a proportion only of the pre-war numbers of pigs and poultry are provided, the ration being further reduced in most cases on the assumption that a farmer should now be able to keep some of his present stock without having recourse to the national pool of feeding-stuffs. Farmers may, however, obtain ration coupons in exchange for milling or feeding oats which they sell or undertake to sell, one unit of protein or, until recently, three units of cereal being issued for every 5 cwt. of oats. To safeguard the position of the wheat grower who is in need of feeding-stuffs because in the national interest he has grown wheat, which may not be fed to livestock, at the expense of fodder crops, a small monthly allocation of feeding-stuffs has been placed at the disposal of Agricultural Executive Committees in wheat-growing areas for issue at their discretion in cases of need.

To facilitate the rearing of chicks for replacement purposes it has been found possible as from January, 1942, to make an allocation of chick food at the rate of ¼ unit per month for every 150 birds kept before the war.

In addition, arrangements are being made for an issue of protein coupons for breeding ewes and calving heifers in cases of need during the early months of 1942.

Agricultural Labour.—There has been no great change in 1941 in the situation with regard to regular workers, but, as the war goes on, work on the farms grows no less, while, on the other hand. the supply of skilled workers has not become any larger. The shortage of skilled workers reported in 1940 has now become rather more marked and widespread. It includes all classes of workers, though ploughmen are in much the greatest demand, followed by orramen, cattlemen and tractor drivers, and it extends down the arable belt on the east coast from Easter Ross southwards and also to the west and south-west, from Dunbarton to Dumfries. Nevertheless, this shortage does not in general seem to be acute. Individual cases of farms where the staffing is inadequate to cope with the work have been reported, but, speaking generally, the supply of regular workers, supplemented by auxiliary labour for seasonal operations, appears so far to have been sufficient to keep pace with the expanding war-time production. Some things on the farms may have had to be neglected, and some operations have been unduly protracted through lack of labour; but the essentials of the 1941 programme have been efficiently achieved, as the array of stacks all over the country and miles of potato pits bear witness.

There is, probably, a relatively greater scarcity of casual than of regular workers. Whether the normal supply of casual workers in 1941 was much below that in 1940 is not very clear, but it was certainly far below the requirements of the 1941 harvest. It is, however, easier to find substitutes for the casual worker than for the regular worker, and this indeed was the main object of the various supplementary labour schemes organised this year by the Department.

Supplementary Labour.—Every opportunity was taken during the year to impress upon farmers that, in view of the call on the nation's man-power for the armed forces and the munitions industries, they would have to make greater use of whatever substitute labour could be made available, whether male or female, to fill regular vacancies. The extent to which women have been taken into agricultural employment is discussed later on in this article. Special efforts were made by the Department to obtain substitute male labour by devising a scheme to assist Agricultural Executive

Committees in the recruitment of workers in Ireland, by obtaining the release from internment of suitable aliens, and by the transfer to agriculture of roadmen found to be surplus to the war-time requirements of highway authorities. While precise information is not yet to hand, it is known that many hundreds of workers have thus been made available for the farmer either as regular hands or to help temporarily at harvest and other busy times. In addition, steps were taken by the Department to conserve and augment the labour force in agriculture and its ancillary occupations by requesting the Ministry of Labour and National Service to take appropriate action in all suitable cases arising under the Undertakings (Restriction on Engagement) Order, 1940, the Industrial Registration Order, 1940, and the Registration for Employment Order, 1941.

The scheme devised early in 1940 empowering Agricultural Executive Committees to organise and employ gangs of workers for hiring out to farmers was more fully operated this year. By the late autumn 13 gangs comprising 106 men were available, and committees were making tentative arrangements for the employment of a further 20 gangs embracing about 350 workers.

Harvest Labour.—Schemes were launched early in the year with a view to assistance being given during the holiday periods by the older pupils at secondary schools and by men and women students at colleges and universities. The principal schemes were the Student Harvesting Scheme, the scheme for the placing of older boys at secondary schools individually on farms, the Holiday Farming Camp Scheme and the Auxiliary Force of the Women's Land Army. Under these schemes some 2,800 workers assisted on the land. Reports indicate that they worked well and that their services were greatly appreciated by the farmers.

Women's Land Army.— A remarkable increase in the popularity of the regular force of the Women's Land Army among Scottish farmers can be reported for 1941. At the beginning of the year about 500 members were in permanent jobs. This figure had risen to 1200 in June and to 1540 in September, while in late autumn over 1600 were regularly employed. In addition 70 girls were in training at institutes or private farms and about 80 were helping with seasonal operations such as potato lifting, making a total of 1750 employed or about to be employed.

The compulsory registration of women under the Registration for Employment Order, 1941, resulted in a large influx of applicants for enrolment, and throughout the year the supply of recruits was more than adequate to meet requirements. Frequently a reserve of over 400 untrained girls was available for farmers willing to train volunteers at State expense in the jobs waiting

to be done on their farms. By October 1000 farmers had taken advantage of this part of the Women's Land Army scheme. The demand for college-trained girls, however, was rather greater than for untrained ones, and it was necessary to increase training facilities by the establishment of three new training centres, viz., Duthie Experimental Farm, Bucksburn, Aberdeen, the College Garden at Nether Liberton, Edinburgh, and the private farm of Mr Waddell, Clury, Grantown-on-Spey. At Bucksburn and Clury, hostels were set up. Organised training was thereby made available for 125 volunteers each month. The demand for trained girls diminished in the autumn and, as a reserve had by then been built up, it was decided that during the winter months enrolled girls who were in non-agricultural employment should not be called up for training. Altogether 1200 had been trained at institutes.

It is regrettable that of the 2200 trained at State expense, either at private farms or institutes, about one-third have resigned or been dismissed from the Land Army. Notwithstanding a high standard of recruitment, many enrolled volunteers were, during training or employment, found to be unfitted, because of lack of aptitude or proficiency, for work on the land; the absence of any element of compulsion contributed to other resignations; while, in some cases, no acceptable permanent employment was available and the volunteers resigned.

In the interests of Land Army members various improvements in working and other conditions were effected during the year. Uniform equipment was augmented by the issue of leather boots, greatcoat, extra breeches, extra coat overall (for dairy workers) and slipper socks for use with gum-boots; a civilian-type steel helmet was also provided. The concession of free holiday travel after six months' service was extended to volunteers working 20 miles (instead of 50 miles as before) or more from their homes. With regard to wages, each volunteer was assured of a net cash wage of at least 16/- a week after paying her board and lodging. Arrangements were made for nursing of sick volunteers, or for their admission to emergency hospitals.

Organisation.—With a view to dealing more expeditiously with the ever-increasing burden of work in connection with the organisation and accommodation of agricultural labour, the majority of the Agricultural Executive Committees have set up special labour sub-committees and appointed labour organisers. Agricultural labour organisation in Scotland has been further strengthened by the appointment centrally of a Labour Advisory Officer to act as liaison with the committees' labour organisers and to give advice on all labour matters. To assist this officer, approval has been obtained to the creation of three Assistant Labour Advisory Officer posts, one of which has already been

filled. The assistants will each cover an agricultural college area and will be stationed in Edinburgh, Glasgow and Aberdeen respectively.

Distribution of Farm Labour.—In the review of Scottish Agriculture in War Time which appeared in the July, 1941, issue of this Journal, mention was made of the concern that had been caused by the drift of workers from agriculture and other basic industries. In an effort to counteract this tendency the Minister of Labour and National Service made the Undertakings (Restriction on Engagement) Order in June, 1940. Besides preventing workers from leaving agriculture, the Order provided for the return to the industry, when they become unemployed, of workers who have had previous agricultural experience. In cases where the provisions of the Order have been infringed, and in other cases where key men have left agricultural employment, the Minister can issue directions to the men concerned to return to work on the land.

The general object of this Order was the conservation of the regular agricultural labour supply. There was, however, nothing to prevent free movement within the industry, and this aspect of the matter, in its relation to production efficiency, presented itself for urgent consideration in the light of the increasing calls on the industry. Widespread movement at the terms, whatever might be its peace-time merits, could not fail to exercise an adverse effect on the war-production programme. Moreover, in the circumstance of an insufficient or barely sufficient labour supply, it was bound to aggravate the existing faults of labour distribution, already considerable; and it effectively blocked the possibility of any measures to deal with such mal-distribution. Consequently, after consultation with the representative bodies of farmers and farm workers, the Secretary of State for Scotland decided last spring that measures must be taken to discourage changes of employment during war time. For actual prevention an Order was required, but, in view of the near approach of the Whitsunday term and the number of cases in which arrangements had already been made, or were in course of being made, for moving, it was not found possible to have the new machinery in operation for that term. However, a strong appeal was made by the Secretary of State in the press and by wireless urging all concerned to refrain in the national interest from making any avoidable changes at Whitsunday. Despite this the number of changes at that term was afterwards reported to have been greater than ever before. This confirmed the need for an Order by the Minister of Labour and National Service, and one was accordingly prepared to provide for prohibiting the termination of all contracts of employment of workers in agriculture, except with the previous permission of

the Ministry, and also preventing the engagement of workers by farmers unless prior approval to the engagement had been given by the local office of the Ministry. In the preparation of the Order the Ministry were in close touch with the Department of Agriculture and with the representative bodies of farmers and farm workers. The Order, entitled the Essential Work (Agriculture) (Scotland) Order, 1941, was made on 2nd October, with 1st November, 1941, as the effective date of its terms.

The main provisions are as follows :—

(1) It is an offence for a farmer to engage a worker without first securing the written approval of the local office of the Ministry of Labour and National Service.

(2) All contracts of employment in operation at 1st November, or any that may subsequently come into operation after compliance with the other provisions of the Order, will continue in force until permission to terminate them is given by a National Service Officer of the Ministry to one of the contracting parties and becomes effective. Application for such permission must be made in writing and the person wishing to terminate the contract must give written notice of his intention to the other party. A farmer may, however, dismiss a worker summarily and without notice for serious misconduct.

(3) It is expressly provided that permission to terminate a contract will not be withheld from a worker who wishes to enter the employment of an Agricultural Executive Committee.

(4) If a farmer or agricultural worker is aggrieved by reason of the grant or refusal of the permission asked for, or if an agricultural worker has been summarily dismissed on the ground of serious misconduct, he may request the National Service Officer to submit the matter to a Local Appeal Board.

(5) The Order applies to all male agricultural workers of 16 years or over except workers employed by the day or by the hour, workers engaged in milking or part-time on common grazings and workers temporarily employed (e.g., university students) on schemes prepared by Government Departments.

As a necessary supplement to the making of the Essential Work (Agriculture) (Scotland) Order it was decided that all Agricultural Executive Committees should be scheduled as Essential Undertakings in terms of the Essential Work (General Provisions) Orders. This was effected as from the beginning of November and as a result the following arrangements will apply to workers of the classes covered by the Essential Work (Agriculture) (Scotland) Order who are employed by committees :—

(1) Committees are under obligation to pay at least the statutory wages continuously to every worker so long as he remains in their employment, is capable of and available for work and is willing to perform such work as he can reasonably be asked to do.

(2) Except in cases of serious misconduct, committees cannot discharge an agricultural worker from their employment except with the consent of a National Service Officer of the Ministry of Labour and National Service; similarly, an agricultural worker cannot leave except with the written permission of a National Service Officer. A worker has the right of appeal against dismissal on grounds of serious misconduct.

(3) The consent of a National Service Officer will normally be given to transfers from committees to other agricultural employment where the transfer is arranged by agreement between the committee, the worker and the new employer.

(4) If committees should have a number of men surplus to requirements and are unable to place them with individual farmers, arrangements may be made through the Ministry for the men to be transferred to neighbouring committees or, if necessary, farther afield.

It is to be specially noted that the Essential Work (Agriculture) (Scotland) Order does not constitute an absolute ban on all transfers from one employer to another. Where a good reason is adduced for a transfer, and where the transfer cannot be regarded as harmful to the national interest in securing or maintaining maximum food production, the required permission will usually be given.

Between them, the Order and the scheduling of Agricultural Executive Committees should provide a sound basis on which committees can carry out the survey they have been asked to undertake to ensure that the best use is being made of all available labour. It will be the duty of each committee to examine the programme and potentialities of each farm in its area and, having regard to these considerations, arrange for the transfer of workers from farms where there is an unduly high proportion of skilled men to other farms where there is a shortage. Wherever possible the places of skilled men so transferred will require to be taken by persons of less skill, whether male or female.

Agricultural Wages.— Following upon the announcement of the Government's policy of raising the level of agricultural wages and of giving compensation to farmers by way of price adjustment for the resultant increase in costs of production, revised minimum rates of wages were incorporated in a series of Orders which became effective at 28th November, 1940. The rate of 48/- was

fixed for adult males in all districts for a 5½ day working week of 50 hours. The rates for specialist workers with longer hours were generally four or five shillings above this figure.

The existing rates were reviewed by committees last October and the new rates proposed were considered by the Agricultural Wages Board in November. Just previously it had been announced that the Wages Board in England and Wales had fixed a national minimum wage of £3 per week, and the Board in Scotland, with this in mind, issued a direction to committees to reconsider the rates they had fixed. The results of this direction were being examined by the Board in the middle of December when this note was written.

Call-up of Agricultural Workers. — The Government announced early in the year that a further call for the Forces was to be made on agricultural workers, and all men under 25 became dereserved at 1st October. During the year the Department and Agricultural Executive Committees have been busy carrying out an examination of applications by farmers for the retention of their key workers, and a selection was made of the men who could be most easily spared for service. The call-up of these men was originally intended to take place on 1st October, but the period was extended beyond that date pending reconsideration by the Government of the whole man-power position. In December the Government announced that the call-up would take place as originally proposed, and at the close of the year the Department, in consultation with the Ministry of Labour and National Service, were making the necessary arrangements

Assistance given to Agriculture by Soldiers.— The War Office continued during the year the arrangements under which farmers might apply for agricultural leave not exceeding 28 days for soldiers who had previously been workers in their employment. Wide advantage was taken of this scheme which has been a great benefit for seasonal work on farms.

The Department continued throughout the year to examine and make recommendations in appropriate cases to the War Office, Admiralty and Air Ministry for the release, either indefinite or temporary, of key farm workers.

Arrangements were authorised by the War Office under which soldiers from local units could be released on a day-to-day basis for harvest work. The Scottish Command co-operated wholeheartedly, and, as a result, considerable assistance was given throughout the country for harvesting grain and root crops.

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